DOCUMENT RESUME

ED 244 580 IR 011 075

AUTHOR Campbell, J. Olin; And Others
TITLE Interactive Videodisc Design and Production Workshop Guide.
INSTITUTION WICAT, Inc., Orem, Utah.
SPONS AGENCY Army Research Inst. for the Behavioral and Social Sciences, Alexandria, Va.
REPORT NO ARI-RN-83-52
PUB DATE Dec 83
CONTRACT MDA-903-78-C-2023
NOTE 197p.; For related documents, see ED 220 071 and IR 011 076.
PUB TYPE Guides - Non-Classroom Use (055)

EDRS PRICE MF01/PC08 Plus Postage.
DESCRIPTORS *Computer Assisted Instruction; Computer Software; Delivery Systems; Design Requirements; Guidelines; Input Output Devices; *Instructional Development; Man Machine Systems; *Military Training; *Models; *Production Techniques; *Videodisc Recordings; Video Equipment; Workshops
IDENTIFIERS *Instructional Systems Development Model; Intelligent Videodisc Systems; Interactive Video

ABSTRACT

This "how to" workshop guide provides an overview of the entire videodisc authoring and production process through six individual modules. Focusing on project planning, the first module provides guidelines, procedures, and job aids to help each instructional development team member effectively use the videodisc medium. The second module describes design and authoring, including the design of text and graphic formats, the computer program, storyboards and orientation material, and special effects and animation. The third module provides details on how to prepare production lists/scripts, select available masters, select talent and music, lay out the disc geography, and plan the production. Production is described in the fourth module, including production of video text frames, animations, art, photographs, and print; shooting location and studio video; recording and editing the audio; and writing the computer program. Special attention is given to the use of video still frames. The fifth module, which focuses on post production and premastering, describes procedures for conducting off-line edits, making the master tape, and entering the videodisc computer program. The final module explains procedures for the mastering stage and for intergrating the computer program with the videodisc. Guidelines for designing interactive videodisc touch panels and voice input are appended. (LMM)

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INTERACTIVE VIDEODISC DESIGN AND PRODUCTION WORKSHOP GUIDE

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December 1983

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IR01107 15

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
REPORT NUMBER Research Note 83-52	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Interactive Videodisc Design and Production, Workshop Guide	5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) J. Olin Campbell David M. Tuttle Andrew S. Gibbons	8. CONTRACT OR GRANT NUMBER(s) MDA 903-78-C-2023 72801
9. PERFORMING ORGANIZATION NAME AND ADDRESS WICAT 1875 S. State St. Orem, UT 84057	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q162722A791
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Ave., Alex., VA 22333	12. REPORT DATE December 1983 13. NUMBER OF PAGES 188
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) U.S. Army Research Institute for the Behavioral & Social Sciences 5001 Eisenhower Ave. Alexandria, VA 22333	15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.	
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)	
18. SUPPLEMENTARY NOTES	
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Videodisc, Interactive Videodisc, Computer-Controlled Videodisc, Videodisc Authoring, IPISD, Systems Approach to Training, ISD, IPISD	
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This is the Workshop Guide for the design and production of Interactive Videodiscs. Modules present: • Analysis and Project Planning • Design and Authoring • Preproduction • Production	

DD FORM 1473 EDITION OF NOV 65 IS OBSOLETE
S/N 0102-LF-014-6601

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ACKNOWLEDGEMENTS

Preparation of this workshop was commissioned by the U.S. Army Research Institute through a competitive contract awarded to WICAT. Jim Baker at ARI saw the need for these authoring procedures when interactive videodisc was mostly a dream. Many people at ARI, including Jack Germas, Leon Nawrocki, Bea Farr, Bruce Knerr, and John Larson have made substantial contributions to the effort. At WICAT, Vic Bunderson has provided many of the guiding ideas for videodisc development that are presented here. In addition, Steve Booth, Stan Jarvis, Neal Christiansen, Gordon Ridd, and Tina Fairweather have developed major portions of the materials and procedures which led to the workshop.

The procedures were used to make the Call For Fire videodisc in conjunction with the U.S. Army Field Artillery School at Ft. Sill, and we acknowledge the assistance of school personnel as well as those in the ARI Field Unit there. The Ft. Gordon Videodisc Microprocessor team then used our revised procedures to create their own interactive videodisc, the RT524 Radio Alignment. The ideas and assistance of Bill Kettner, George Frye, Lou Hattman, Jim Frye, 1LT Sam Palmisano, Tom Thumlin, SFC Sanford Barshafsky, SFC Woodrow Chargois, and Tim Springfield at Ft. Gordon are gratefully acknowledged.

DEDICATION

Making an interactive videodisc is both exhilarating and frustrating. The process can be surprisingly complex because it draws together video design and production, graphics, computer programming, instructional design, and content expertise. That combination of disciplines and styles can yield new ways of seeing, or it can spell disaster if those involved fail to work together. The central character in the drama is a person we call the Producer.

The Producer can be from any discipline. He or she owns the overall effort because of a guiding sense for what the program will feel like and how it will work. The Producer must help the content expert, video director, programmer, and others to share that sense and to work together to make it a reality. It is not an easy job.

The workshop presents a well-tried and successful procedure. This manual provides a low cost means to distribute the non-hands on portions of the workshop. But there is a richness of experience that can be gained only by trying out several types of interactive videodisc programs and by trying your hand at the process. Whether it is at a workshop or in your first production we trust that this guide will help you avoid some of the pitfalls and feel more of the excitement of opening a new medium -- interactive video.

This workshop guide is dedicated to those who are determined to become interactive videodisc producers.

Interactive Videodisc: Design and Production

Workshop Agenda

Monday

8:00 p.m.	Hands on Tryout of Several Programs

Tuesday

8:30 a.m.	Formation of Small Groups, Problem Exposure, and Overview of Interactive Videodisc Design/Production
9:45 a.m.	Break
10:00 a.m.	Project Planning - Presentation Modes, with Demonstrations
10:30 a.m.	The Producer and Team Leaders
11:00 a.m.	A Mock Planning Conference
12:00 p.m.	Lunch
1:15 p.m.	Selecting the Delivery System Hardware -- Hands-On Tryout of Alternatives
2:00 p.m.	Time and Costs for Design/Development/Delivery System
2:30 p.m.	Break
2:45 p.m.	Authoring - Finding An Expert
3:15 p.m.	Designing the Program Maps - Small Group Project
4:00 p.m.	Designing A User Interaction Scenario and Screen Displays - Small Group Project

Wednesday

8:30 a.m.	Designing Software User Requirements, Selecting/ Designing Software Templates, and Flowcharting - Small Group Project
	- Break at Discretion of each Group
	- Continue Software Design Projects
11:30 a.m.	Lunch
1:15 p.m.	Designing Display Formats and Special Effects
1:45 p.m.	Developing Storyboards and Templates -- Demonstration
2:15 p.m.	Break
2:30 p.m.	Storyboards and Templates -- Small Group Projects
4:30 p.m.	Formative Tryouts Using Storyboards
5:00 p.m.	Pre-Production -- Planning and Procedures

Thursday

8:30 a.m.	Production - Video Text and Graphics
9:30 a.m.	Location Shooting
10:00 a.m.	Break
10:15 a.m.	Software Editors and Drivers
10:45 a.m.	Studio Video and Audio Production
11:15 a.m.	Postproduction - Work Tapes, SMPTE Codes, Off-Line Edits, and Edit Decision Lists
12:00 p.m.	Lunch
1:15 p.m.	Off-Line Edits -- Hands-On Tryout
2:15 p.m.	Break

Thursday (cont.)

2:30 p.m.	The Postproduction Studio
3:30 p.m.	Using A Computer Authoring System -- Small Group Hands-On Session

Friday

8:00 a.m.	Mastering
9:00 a.m.	Content Checkout and Revisions -- Small Group Hands-On Session
11:00 a.m.	Wrapup and Evaluation

INTRODUCTION

This workshop is a "how to" introduction to the process of designing and producing interactive instructional videodiscs. It is module oriented, with each module directed to both the producer and team members.

The procedures, forms and materials in this workshop were designed on the basis of experience with projects ranging from Army forward observer training to biology instruction for college students, and from electronic troubleshooting on a complex missile system to medical diagnosis training for gastroenterologists. These course materials present systematic and easily modifiable authoring and production procedures for interactive videodisc development. They are extensions of commonly used procedures as specified in the Interservice Procedures for Instructional Systems Development (IPISD) model (TRADOC, 1975).

These materials may be used by themselves or as part of a group workshop. In either case you will get more from them if you use them as a guide to preparing actual instruction. Use of these modules and materials can save time and frustration in your initial projects.

Intended Audience

This workshop is designed to be a useful tool for:

- managers or directors of instructional development charged with the overall responsibility for developing an interactive videodisc.
- authors and writers responsible for organizing the lesson material.
- TV directors and video production managers involved in producing the media that will appear on the interactive videodisc.
- producers and project directors

Course Objectives

During the course of this workshop, you will get an overview of the entire authoring and production process and will learn how to plan a videodisc project (Module 1); prepare a storyboard for a segment of instruction (Module 2); complete guides for graphic, audio, and visual displays, and lay out the physical space on the videodisc (Module 3); anticipate production challenges for interactive videodisc

development (Module 4); create an edit decision list and produce a programming guide (Module 5); and plan the activities during mastering based on the type of videodisc (Module 6). In addition, you will learn about the supporting activities for these major authoring and production tasks.

Use of Course Modules

Each module focuses on different members of the development team and is complete within itself. A training workshop may be presented in which these materials are tailored to a specific project. Typically, you will work through this guide by yourself or in a workshop setting, then refer to it during the actual development of an interactive videodisc. The forms and procedures included in these materials are suggested formats and should be adapted to your project's requirements.

Assumptions

It is assumed that persons utilizing this workshop course are already reasonably familiar with the instructional development process.

Use of these materials assumes that the program of instruction will be defined through standard "front-end analysis" procedures and that "lesson design specifications" will be developed for the content of the interactive videodisc(s). These can be extensive processes. They are referred to here only briefly since the focus of this presentation is on videodisc-specific procedures. Decisions regarding instructional strategies are assumed to be made explicit in the lesson specifications.

These materials assume the availability of a video character generator and a computer editing facility or still frame store. This equipment is used for developing computer-controlled branching, answer processing, and computer-generated frames and data which are available through a full-function authoring system.

This presentation is oriented to computer-controlled videodisc programs, especially those where the computer offers a standard programming language or authoring system. We also describe use of computer-generated overlays over the videodisc image.

We also assume use of constant angular velocity (CAV) optical videodiscs with a capacity of approximately 30 minutes per side, together with still frame capability.

Acronyms

In this course, the following acronyms are used:

- CAI stands for computer-assisted instruction. In the context of the interactive videodisc, CAI refers to the interactions between courseware and user in any of a variety of learning modes and instructional strategies.

- CMI stands for computer-managed instruction. It deals with the registration and tracking of student progress by means of practice, quizzes, milestone examinations, etc. Thus it involves test scoring, with diagnosis and prescription based on the testing. Besides accounting for student progress through a course, CMI handles data processing requirements of class and individual performance, providing reports for learners and instructors. In addition, this capability controls which lessons constitute courses, and the creation of classes, assignments, and system reports.

- IVD stands for interactive videodisc. It is differentiated from a non-interactive disc in the way it delivers instruction. While it uses the videodisc as the storage medium, a computer controls answer processing, branching and feedback, thus personalizing the instruction in response to each individual user.

- ISD stands for Instructional Systems Development. It is a set of techniques and procedures followed in the development and implementation of training materials. The Interservice Procedures for Instructional Systems Development is used as a standard for this course, though there are several development models that could be used. The major phases of this model appear under the following or similar names in most development projects: (1) analysis, (2) design, (3) development (4) implementation, and (5) evaluation or control.

- SMPTE stands for Society of Motion Picture and Television Engineers. Here it refers to their time code of elapsed hours, minutes, seconds, and frames, placed on the videotape to provide location information. It is usually written here as a six digit code, although it may also appear as an eight digit code (e.g., 00:15:36:21).

OVERVIEW

This module will prepare you to:

(1) Briefly describe the major characteristics of videodisc players and NTSC video.

(2) Present a range of total costs and cost per contact minute for interactive videodisc development, and describe several factors that determine costs.

(3) List the five phases of the instructional systems development model.

(4) List the six stages of the interactive videodisc design and production process.

(5) Describe major activities performed in each of these interactive videodisc development stages.

Videodisc Features

The advent of high density optical recording systems like the videodisc, digital audio disc, and optical data tape has tremendously expanded our ability to have a wealth of information at our fingertips. In the case of the videodisc, this information comes as color television images either in motion or as stills, dual channel audio, and some limited digital information.

Government and Industry are just beginning to see the possibilities of optical recording. For example, instead of the relatively low resolution American standard broadcast television pictures currently available on American videodiscs, the videodisc technology could as easily deliver high definition video that rivals 35mm film for clarity. In fact, the disc itself, while a convenient format, is by no means the only way in which optical recordings can be delivered. Video cubes are a distinct possibility, for example.

High density digital information can be stored using the same basic techniques. This digital information can then be used to store computer programs, data, digitized visual images, and digitized audio. The prototype digital audio discs that are now being demonstrated are examples of application of this technology in the audio arena. These discs offer exceptional fidelity and dynamic range.

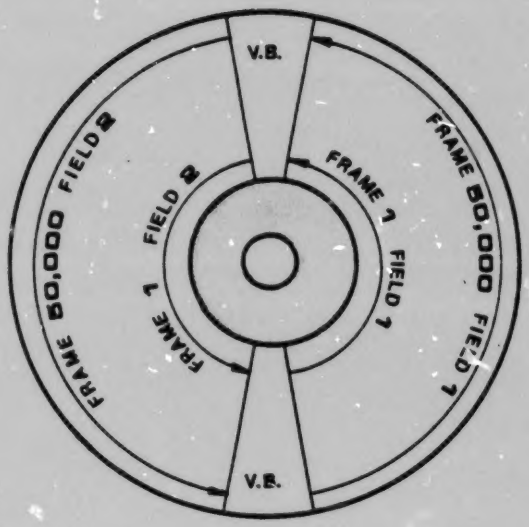
While very high density optical recording is a key component in the systems described in this workshop, high density magnetic recordings are also becoming available. These offer the capability of recording and modifying the information that is stored. Digital magnetic video still frame stores that are currently on the market (albeit at a high price) are examples of this technology.

The focus is on the optical videodisc simply because it is here and available today. In contrast to the capacitance and "needle in the groove" video systems also marketed in the United States, some optical videodisc formats permit the user to view a single frame indefinitely. Because the information is read with a laser rather than by a physical contact device, there is virtually no wear on the videodisc. These features, combined with the extremely high density of information, make the optical videodisc an excellent source of visual images and audio for education and training applications.

Functions available with most players include motion at 30 frames per second (standard video speed), stills, dual track audio, slow motion and fast motion, and rapid search. Some players include circuits to search to any given frame on the disc, and to automatically search to the next chapter or to stop at a specially identified picture. Some offer a small built-in computer to allow the player to be programmed either by a remote keypad or by a program resident on the disc itself.

Most optical videodisc players on the market today operate in either a 30 minute per side mode which allows stopping on individual frames or an extended play, 60 minute per side mode for longer sequences of motion (e.g., feature length movies). The former mode is called Constant Angular Velocity (CAV). This means that the disc turns through a constant angle in a given time. This is important because the player can then always know where it is on the disc and can therefore locate single frames. The 60 minute mode is known as Constant Linear Velocity (CLV). Figure 1 distinguishes these two modes. In CAV mode information must be packed much more densely at the center of the disc than it is at the outer edge, where the perimeter is larger. In some sense this less densely packed information at the outer edge wastes space, but on the other hand, since a new frame always begins at a known location on the disc, it provides the capability for still frames. In the CLV disc, the information is packed as densely as possible throughout the videodisc. This means that playing time is longer, but it is not possible to retrieve individual frames.

Information is recorded starting at the center of the videodisc and continuing in a spiral to the outer edge. CAV discs rotate at a uniform 1800 revolutions per minute. CLV discs rotate at 1800 RPM when information is being read from the center of the disc, but slow to 600 RPM when information is read from the outer edge at the end of the program. Because information is packed most densely at the center of a CAV disc and throughout a CLV disc, quality tends to be most critical at these places.



Constant Angular Velocity
(CAV) Videodisc format

Constant Linear Velocity
(CLV) Videodisc format

Note: Frame numbers are examples. Vertical blanking (VB) occurs between every field.

Figure 1: Comparison of CAV and CLV Videodisc Formats

Videodisc Players

Four companies currently market optical videodisc players. These are Magnavision (Magnavox/Philips), Pioneer, DVA, and Sony. Pioneer manufacturers for DiscoVision. Thomson CSF formerly manufactured and marketed a transmissive disc player in which the laser beam passed through the disc, but this system is not currently on the market. All are reflective players in that the laser beam is reflected from the disc surface. Various models from these manufacturers fit the descriptions of consumer, industrial/education, and computer-controlled players (also known as level one, level two, and level three, respectively), that are described in the workshop section, "Define Delivery System Hardware/Software." You should talk with the users of these systems and with the player companies' marketing departments to determine which player best fits your needs.

Video Characteristics

This section presents a very brief overview of video characteristics as they apply to videodisc production.

The United States uses the NTSC standard for broadcast television. The standard prescribes many characteristics of the signal, but the most important for our purposes is that it provides 525 scan lines. Some of these are above and below the picture area on a television set or monitor. Other countries have adopted other standards, including a 625 line system. A number of firms have proposed a high definition television standard of 1100 scan lines. The latter is roughly comparable to 35mm film in its resolution.

The more scan lines in the signal, the more information the signal must contain, and therefore its bandwidth must be broader. The American NTSC standard is a compromise that allows reasonable fidelity, while limiting the crowding of the air waves with broadband signals. High definition TV, for example, would probably have to operate in an extremely high frequency range that is less crowded. Signals using high definition TV could be beamed directly to homes from satellites, or could be delivered via special high definition videodiscs.

The NTSC standard video is a definite constraint on videodisc production. For example, in practical terms about 12 lines of 32 characters each is the maximum text that is usually placed on a video screen for delivery using the NTSC standard. Personal computers linked directly to a television set can provide more characters than this, but they do not have to be transferred from one medium to another, with resulting loss in quality. The remainder of this discussion will focus on the NTSC standard.

The video picture consists of 30 individual frames per second. Each frame consists of two interlaced fields. This means that an electron beam scans down the video screen painting every other line for one field, then jumps back up and paints the alternate lines for the other field. The two fields are usually termed field 1 and field 2, or field A and field B. In essence, 60 fields per second are presented. Figure 2 presents this graphically. If the subject moves in the 60th of a second between the two fields, there will be some jitter as fields alternate on a still frame from the videodisc. In normal television, which is always presenting motion, this jitter is not noticed, but it can become quite distracting in still frames.

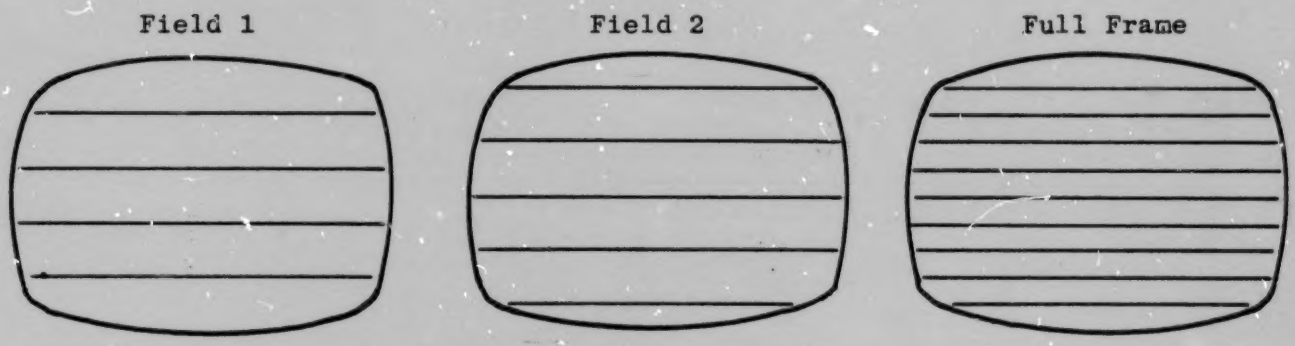


Figure 2. Relationship of Video Fields

Video has some other characteristics that must be taken into consideration when preparing color art for graphics. Usually, graphics transfer to video better than text because graphics tend to present a complete image where some loss of resolution for one part does not detract from your ability to see the whole. On the other hand, loss of one or two letters in a word can prevent the word from being understood. Another factor to consider is that contrast between colors and backgrounds must generally be much lower for video production than for print. For certain technical reasons, some colors tend to interact when placed together on a video screen. This is known as "chroma crawl." Experienced video directors can provide guidance on character size, graphics, and appropriate color combinations. You should plan to experiment with these prior to committing to a format to be used throughout the videodisc production.

Many other factors affect the quality of the video image. In particular, television sets and monitors have a profound effect. Therefore, you should be careful to view your experiments on the same monitor that you plan to use to deliver the materials, as opposed to a high quality studio monitor.

The IPISD Model

The process of developing interactive videodiscs includes the design of instructional materials, the authoring of a storyboard script, the production of audio, graphic, and visual materials, preparation of the master videotape, videodisc mastering, and software programming.

Figure 3 presents the IPISD (Interservice Procedures for Instructional System Development) model (TRADOC, 1975) which serves as a basis for instructional development in the workshop modules. The IPISD model consists of five major phases: I) Analyze, II) Design, III) Develop, IV) Implement, and V) Control (evaluate). Although any well-defined procedural model would help define the process of development, the IPISD model provides an orderly framework for monitoring progress and managing the overall development effort. It also allows for informed decision-making and for effective coordination of team member roles and functions.

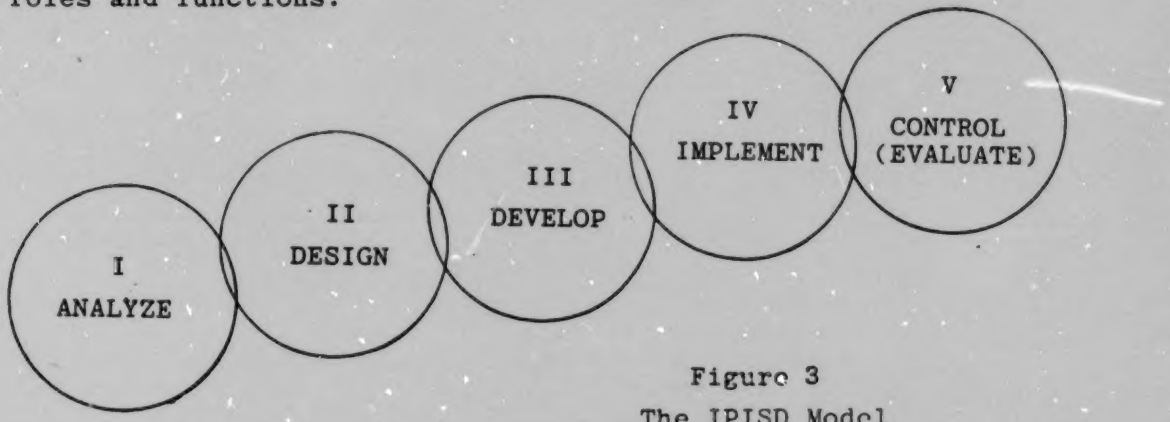


Figure 3
The IPISD Model

Figure 4 provides a detailed listing of the functions for each of the five phases of the IPISD model:

THE FIVE PHASES ARE:

PHASE I
ANALYZE

Inputs, processes, and outputs in Phase I are all based on job information. An inventory of job tasks is compiled and divided into two groups: tasks not selected for instruction and tasks selected for instruction. Performance standards for tasks selected for instruction are determined by interview or observation at job sites and verified by subject matter experts. The analysis of existing course documentation is done to determine if all or portions of the analysis phase and other phases have already been done by someone else following the ISD guidelines. As a final analysis phase step, the list of tasks selected for instruction is analyzed for the most suitable instructional setting for each task.

PHASE II
DESIGN

Beginning with Phase II, the ISD model is concerned with designing instruction using the job analysis information from Phase I. The first step is the conversion of each task selected for training into a terminal learning objective. Each terminal learning objective is then analyzed to determine learning objectives and learning steps necessary for mastery of the terminal learning objective. Tests are designed to match the learning objectives. A sample of students is tested to insure that their entry behaviors match the level of learning analysis. Finally, a sequence of instruction is designed for the learning objectives.

PHASE III
DEVELOP

The instructional development phase begins with the classification of learning objectives by learning category so as to identify learning guidelines necessary for optimum learning to take place. Determining how instruction is to be packaged and presented to the student is accomplished through a media selection process which takes into account such factors as learning category and guideline, media characteristics, training setting criteria, and costs. Instructional management plans are developed to allocate and manage all resources for conducting instruction. Instructional materials are selected or developed and tried out. When materials have been validated on the basis of empirical data obtained from groups of typical students, the course is ready for implementation.

PHASE IV
IMPLEMENT

Staff training is required for the implementation of the instructional management plan and the instruction. Some key personnel must be trained to be managers in the specified management plan. The instructional staff must be trained to conduct the instruction and collect evaluative data on all of the instructional components. At the completion of each instructional cycle, management staff should be able to use the collected information to improve the instructional system.

PHASE V
CONTROL

Evaluation and revision of instruction are carried out by personnel who preferably are neither the instructional designers nor the managers of the course under study. The first activity (internal evaluation) is the analysis of learner performance in the course to determine instances of deficient or irrelevant instruction. The evaluation team then suggests solutions for the problems. In the external evaluation, personnel assess job task performance on the job to determine the actual performance of course graduates and other job incumbents. All collected data, internal and external, can be used as quality control on instruction and as input to any phase of the system for revision.

Figure 4
Functions of the Five Phases of IPISD

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In Figure 5 each major phase is broken down into blocks of specific activities. The arrows illustrate how each activity flows into the next, from phase to phase:

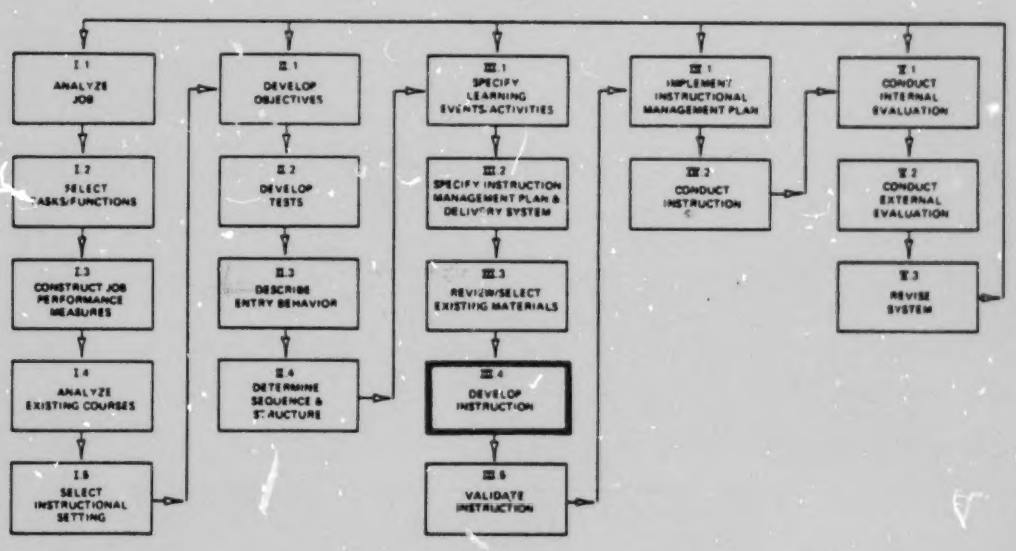

Figure 5
Activities in Each IPISD Phase

In the context of the IPISD model, we are primarily concerned with the DEVELOP phase (III), and more specifically with the box in Figure labelled III.4. While there is a general discussion of audio-visual production in that step, a great deal more detail and guidance is necessary for interactive videodisc authoring and production. The workshop presents that detail, along with changes to other IPISD steps that are related to interactive videodisc. You are encouraged to consult the full IPISD model if you are not already familiar with it. While other approaches are being proposed and drafted, it is a current standard.

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The Major Stages of Videodisc Design and Production

The design and production of interactive videodiscs may be divided into six major stages:

- Analysis and Project Planning
- Design and Authoring
- Pre-Production
- Production
- Post-Production/Pre-Mastering
- Mastering

Analysis and Project Planning

In this stage, the major tasks involve analysis and planning conferences to determine instructional strategies, followed by the selection of available audio and visual materials and a review of the capabilities of the delivery system.

The project planning stage provides a finalized set of materials and documents as raw materials for the authoring stage as well as specifications for all videodisc interactions.

Design and Authoring

The major tasks in this stage involve writing production sheets, conducting a limited tryout of the lesson, and revising the overall presentation.

The major product is a set of production sheets that has been carefully reviewed and approved for production.

Pre-Production

Prior to actually producing the video, audio, and graphics, production lists need to be prepared, detailing instructions for production personnel. The layout of the disc geography must also be planned to minimize branching times.

As a result of these activities, complete specifications for all audio and visual materials will be finalized.

Production

The major tasks in this stage involve the creative resources of media personnnel in the actual production of audio, video, and graphic materials. The programming of special functions required in the lesson must also be completed.

At the conclusion of the production stage, all of the source materials must be prepared.

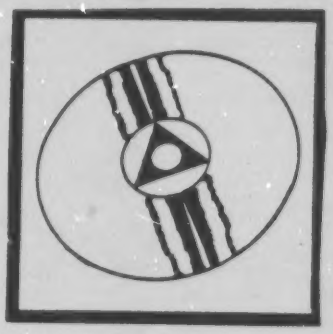
Post-Production/Pre-Mastering

The major tasks during this stage consist of doing film transfers, editing work tapes, and preparing a master videotape for making the videodisc master.

The final output of this stage is an edited and approved videotape.

Mastering

The actual mastering of the interactive videodisc involves a series of processes at a mastering facility and may require several weeks to complete. The final result is the desired number of videodisc copies ready for distribution.



Interactive Videodisc Development

Figure 6 shows the steps required to design and produce an interactive videodisc. For best results, each step should be completed in the sequence shown, although some activities may overlap in practice. The overall schedule shown here--20 weeks from initial concept to approved master--suggests the time typically required for a well-managed project of medium complexity, using primarily studio production (with one or two scenes shot on location), about 300 still frames, and a modest computer program. Simpler programs require less time, while those employing sophisticated computer simulation techniques take longer--both to plan and to produce. For videodiscs controlled by an external computer system, program coding and testing can continue during the mastering of the videodisc.

Appendix A summarizes some of the lessons learned about videodisc development. Many of those points are expanded in the remainder of the workshop.

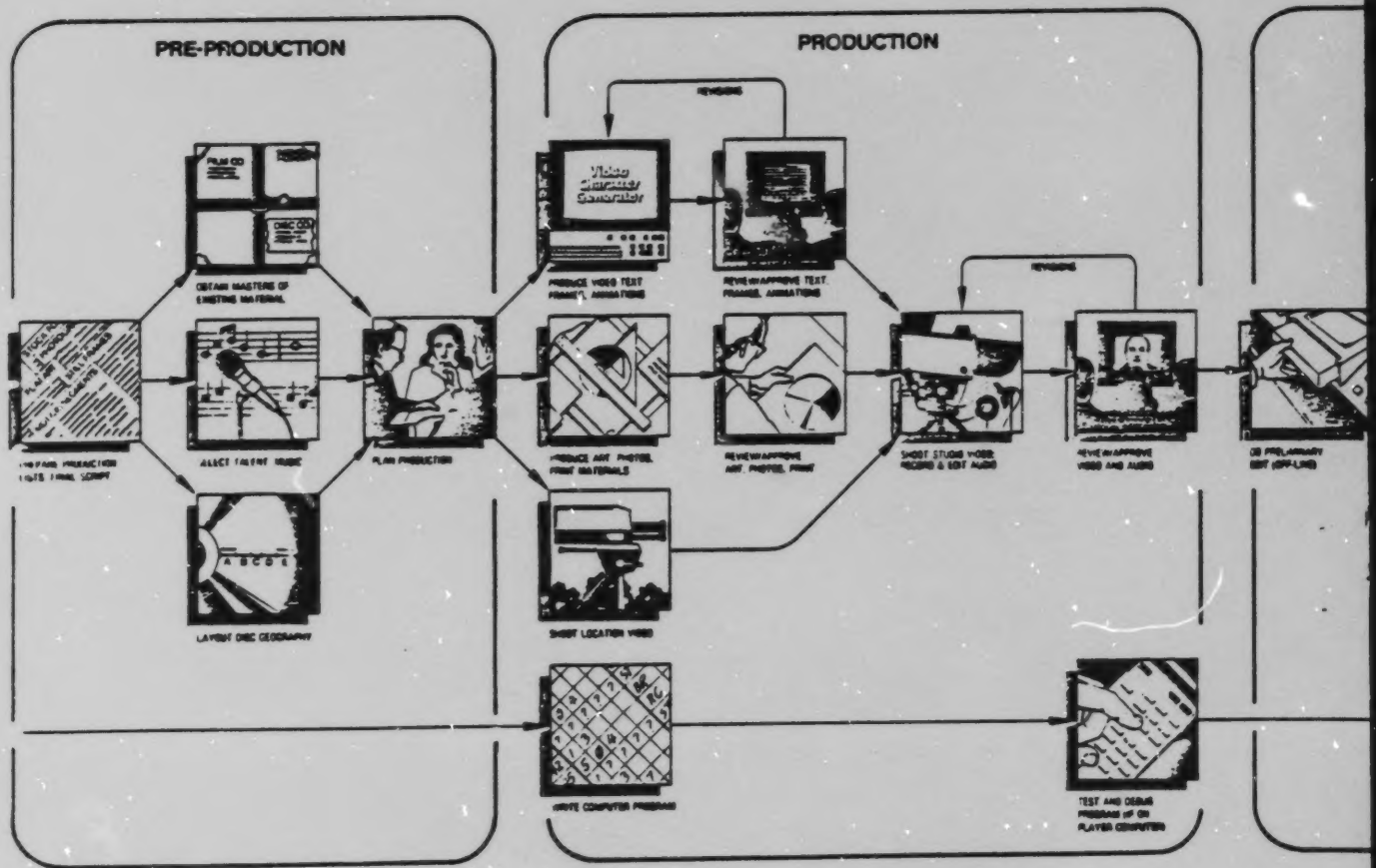
Costs

The costs for interactive videodisc development depend dramatically on the length and nature on the program. If you will take an existing motion videotape, insert a menu at the beginning, and then let the users simply search to the first frame of the section of interest, development costs will be little more than the price of mastering -- about $2500 per videodisc side. On the other hand, if you are developing a full course, including simulations, the cost of development is likely to range from $100,000 to $200,000. A typical first-time, one of a kind, interactive videodisc simulation with 5 to 10 hours of interactions using a linear simulation or very limited system simulation mode would likely fall in this range. Delivery systems are not included and would likely cost about $5000 to $20,000 each for this type of interaction. A complete system simulation would likely cost more. Replica (3-D) simulators attached to the interactive videodisc simulation send up costs very rapidly. A short, strictly linear simulation using off-the-shelf materials that was part of a series (so that the team, facilities, and equipment were already in place) could be developed for much less.

It is interesting to compare costs in terms of user contact time. We have produced a videodisc in the generative mode (where the computer generates new problems) that contains approximately 50 hours of instruction on one side of a 30 minute videodisc. A more typical program would have 5 to 10 hours of interaction on one side of the disc. The cost works out to between $200 and $600 per contact minute. It is interesting to compare this to instructional videotape costs that typically run between $2000 and $4000 per minute without interactions.

The reason for this cost differential is primarily in the still frames. One minute of motion on the videodisc comprises 1800 frames. At 10 seconds per frame, 1800 still frames is five hours of user time.

INTERACTIVE VIDEODISC DESIGN AND PRODUCTION



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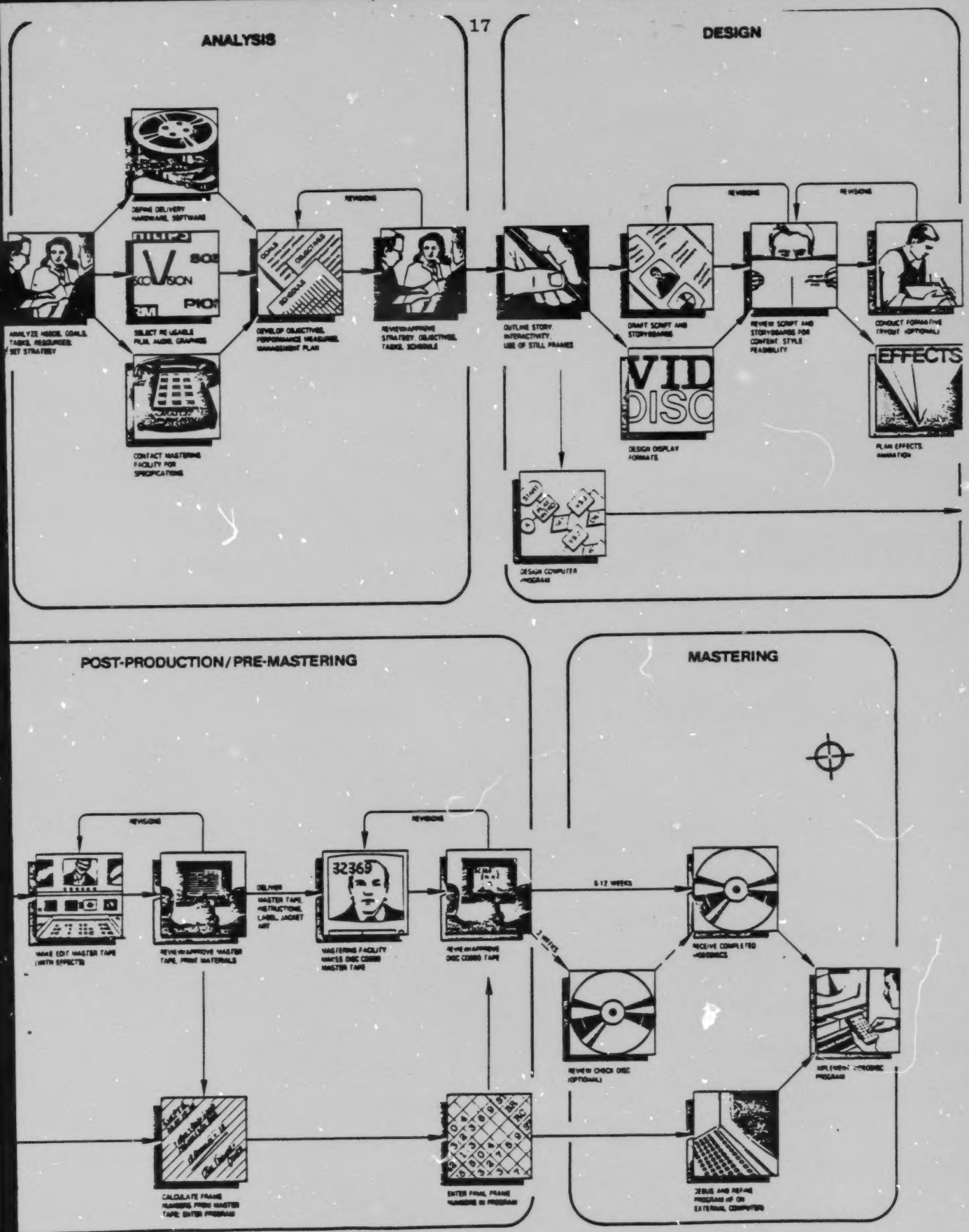

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You should be careful of hidden costs in interactive videodisc production. For example, an Army base may have a dedicated television studio, graphics shop, instructors, and instructional developers. These can be allocated to a videodisc production, and their salaries, equipment, facilities, benefits, and other overhead may not be made explicit. Nevertheless, someone must pay the bill. Your organization may be able to command such in-house services. If so, the cost is that required to make the arrangements. However, if you must go outside of your own organization, these hidden costs will become readily apparent.

MODULE 1

ANALYSIS AND PROJECT PLANNING

The interactive nature of computer-controlled videodisc typically requires more detailed planning and design than traditional media presentations. This module presents guidelines, procedures, and job aids which will help each member of the instructional development team to make the most effective use of this new delivery system.

Specifically, this module will help prepare you to:

(1) Describe five interactive videodisc presentation modes.

(2) Describe the needs and potential for 2D interactive video simulation.

(3) Explain the roles of interactive videodisc development team leaders.

(4) List the major steps in planning interactive videodisc projects.

(5) Describe the four different levels of videodisc delivery system capabilities.

Presentation Modes

There are five basic types of presentation modes, each of which may appear in well-designed training materials using an interactive videodisc delivery system:

The page turner mode allows menu-selected motion segments or text/graphics to be presented with accompanying audio in any combination. Examples are sales presentations, museum-on-a-disc, and job aids. This mode is similar to a slide/tape or random access videotape.

The branching mode enables students/users to respond to fixed questions and to receive immediate feedback. Branching to appropriate drill and practice segments depends upon the answers. (Without two screens or text/graphics overlay, most videodisc systems stop with this mode.)

The generative mode creates items or draws them from a large array of problems. One example is an art game that randomly draws pictures from one school of artists at a time. Another example is placing computer-generated targets on a videodisc map and asking students to call the coordinates of the target.

The linear simulation mode is a relatively invariant sequence where the user progresses to the next step only when the current step is completed. It is relatively simple to construct since the system need not be modeled. Examples are equipment setup and alignment simulations, or "canned" problems.

The system simulation mode models the functional characteristics of a system and allows the user to exercise the system in a realistic two-dimensional environment. An "expert" can be built into the system to monitor user responses and perform corrective actions such as offering hints and suggestions or prescribing reviews and other types of exercises. Examples are an electronic trouble-shooting simulation or simulated tank driving.

The Creative Potential of Interactive Videodiscs

The interactive videodisc delivery system offers tremendous instructional flexibility in the type of design formats available to developers. The 54,000 frames per side provide a large capacity for truly interactive instruction. However, the power of this medium can be easily wasted if it is used only as a page turner or movie player.

One of the challenges to first-time users of interactive videodisc is to think creatively and imaginatively, to experiment and play with the medium, and to move beyond merely transferring existing audio and visual materials onto videodisc. Although the videodisc delivery system is certainly capable of turning the pages of an electronic book, of presenting video playback, and of delivering programmed instruction, it can also generate problems, give the user control over motion sequences of complex procedures, play games, and deliver highly interactive simulations. Reading text from a videodisc is about as exciting as reading it from a book. However, for conceptual planning and other non-hands on components, text is often the most effective means to delivery instruction. For a hands-on task, seeing and doing something instead of reading about it can be far more engaging. Simulations and games offer this potential.

Figures 1-1 through 1-16 present the case for using interactive video simulation. We describe what it is, the need, and the potential. These are the reasons we recommend making your first project a simulation. We also recommend a linear simulation, as described above, because it is one of the easiest to develop and yet makes good use of interactive video. There is great interest today in interactive video (2D) simulation because it provides much of the realism and skills training of actual situations or of 3D replica simulators at a price that can be orders of magnitude less.

INTERACTIVE VIDEO

SIMULATION

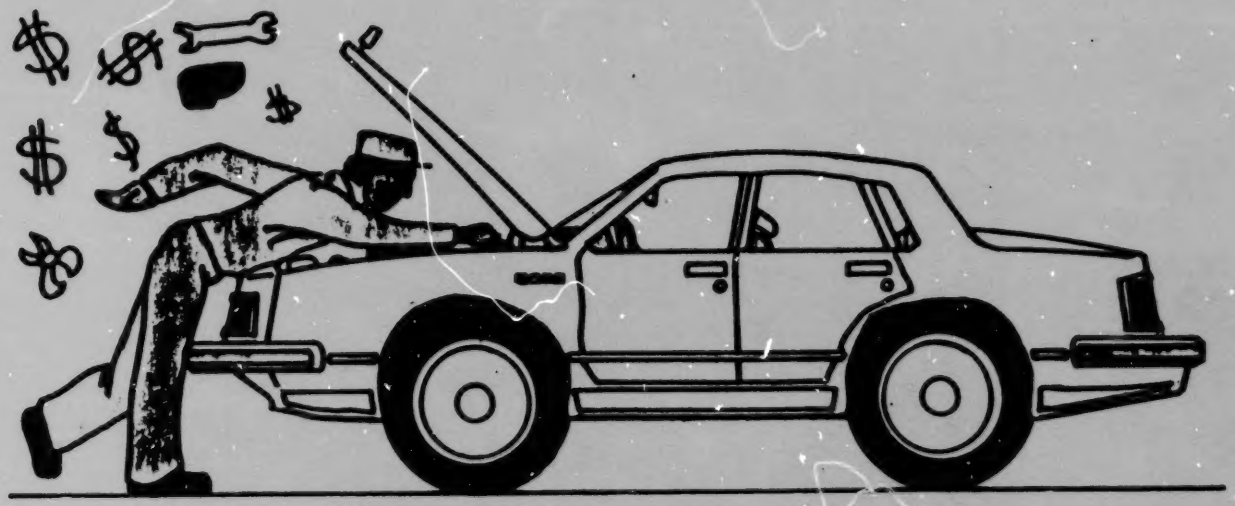
WHAT IT IS

- Representation of Dynamic Systems
- Can be manipulated
- Use TV screen or CRT
- Hardware is content-blind: One set of Hardware simulates many systems

Figure 1-1

THE NEED

Example 1 - Troubleshooting by Replacement

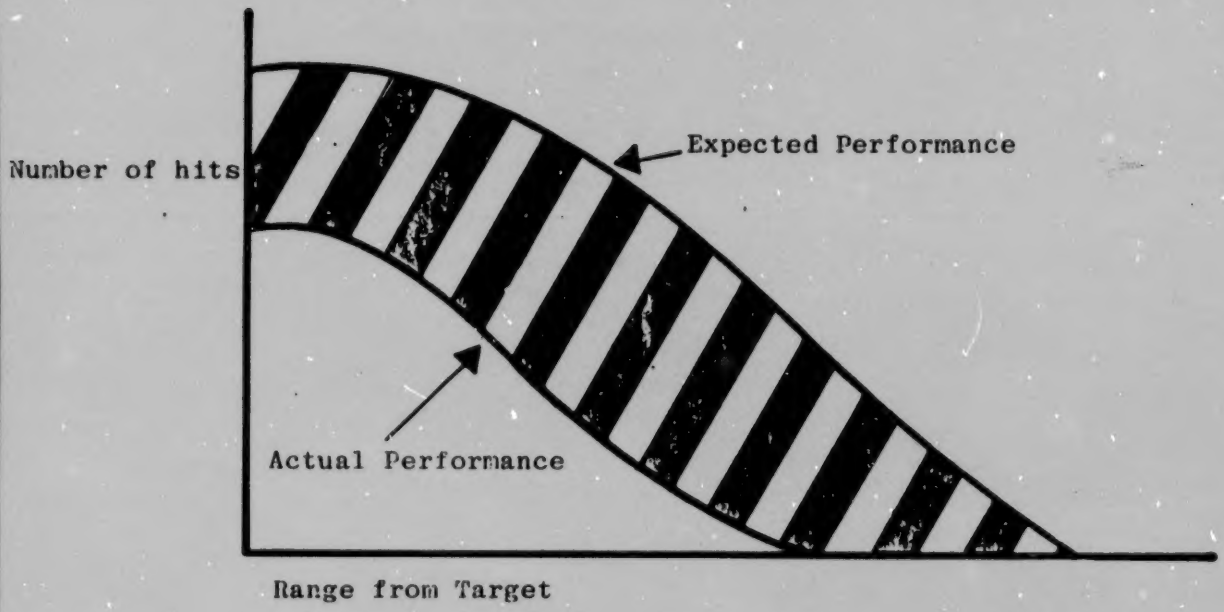


The standard mode of troubleshooting complex electrical/mechanical systems is to replace parts until something works. This is costly and can induce new failures.

Figure 1-2

Example 2 - The Effectiveness Gap:

A Serious Problem for National Defense

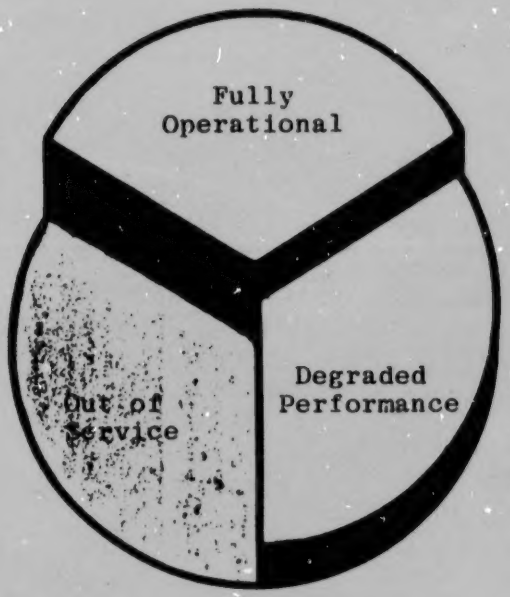


Operators are not using their systems to get the maximum effectiveness.

Figure 1-3

THE NEED

Example 2 (cont) - READINESS

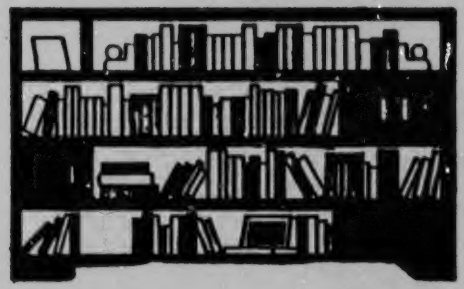


A high proportion of equipment is out of service or provides degraded performance because it is improperly maintained.

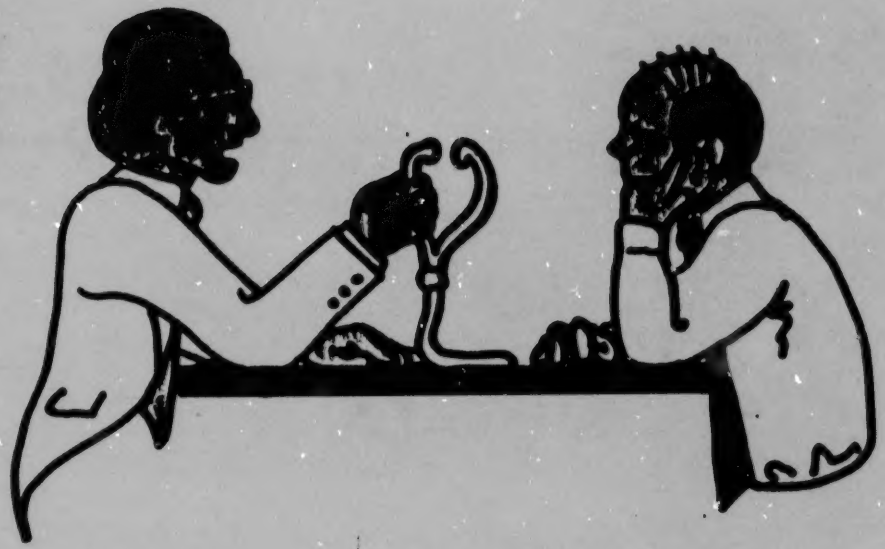
Figure 1-4

THE NEED

Example 3 - Professionals Keeping Up to Date



1-7



The volume of new medical information makes it difficult for physicians to keep up to date.

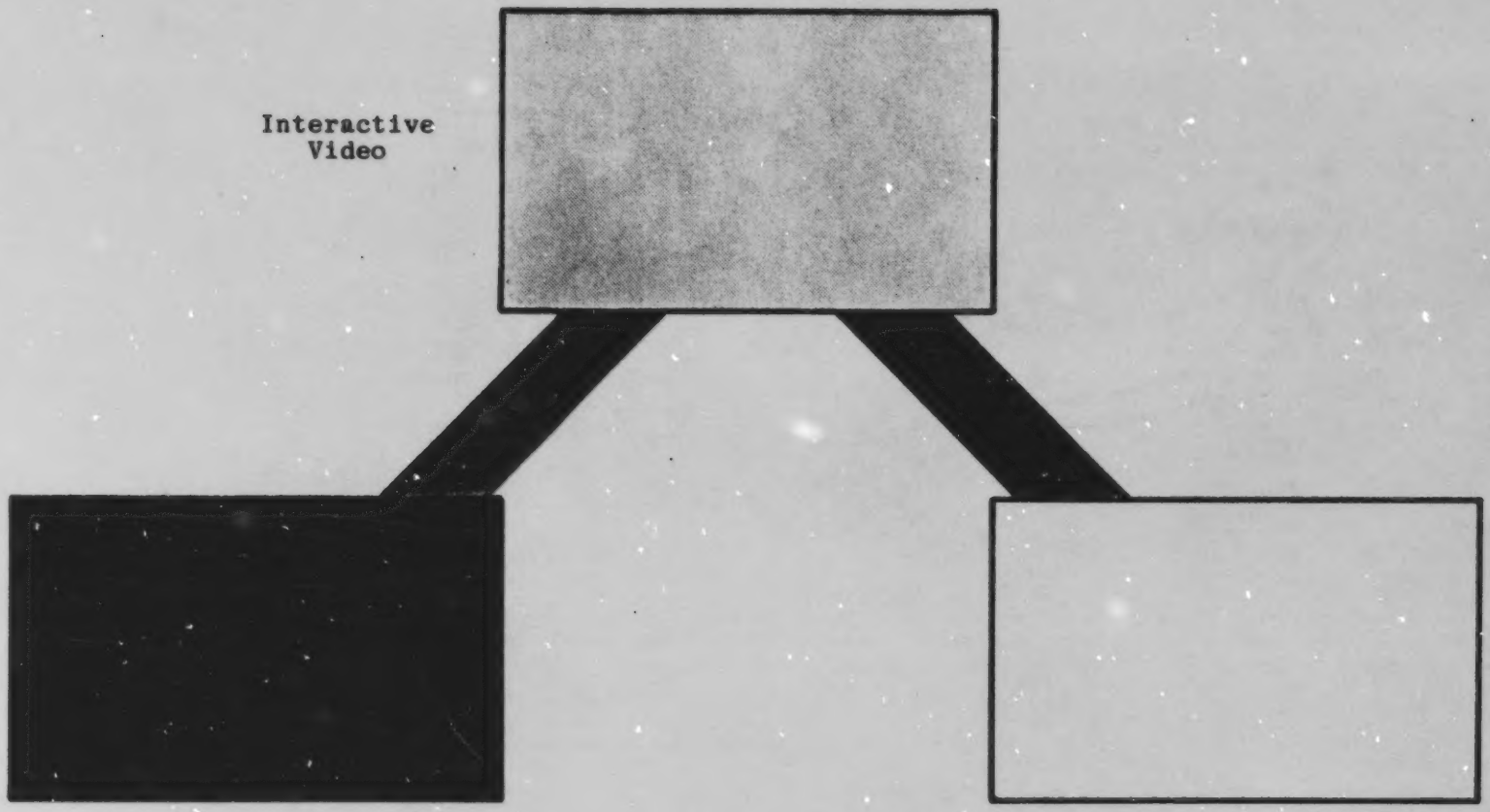
Figure 1-5

Example 3 (cont) - Professionals Keeping Up to Date

Attorneys must keep abreast of new precedents and decisions affecting their cases.

Figure 1-6

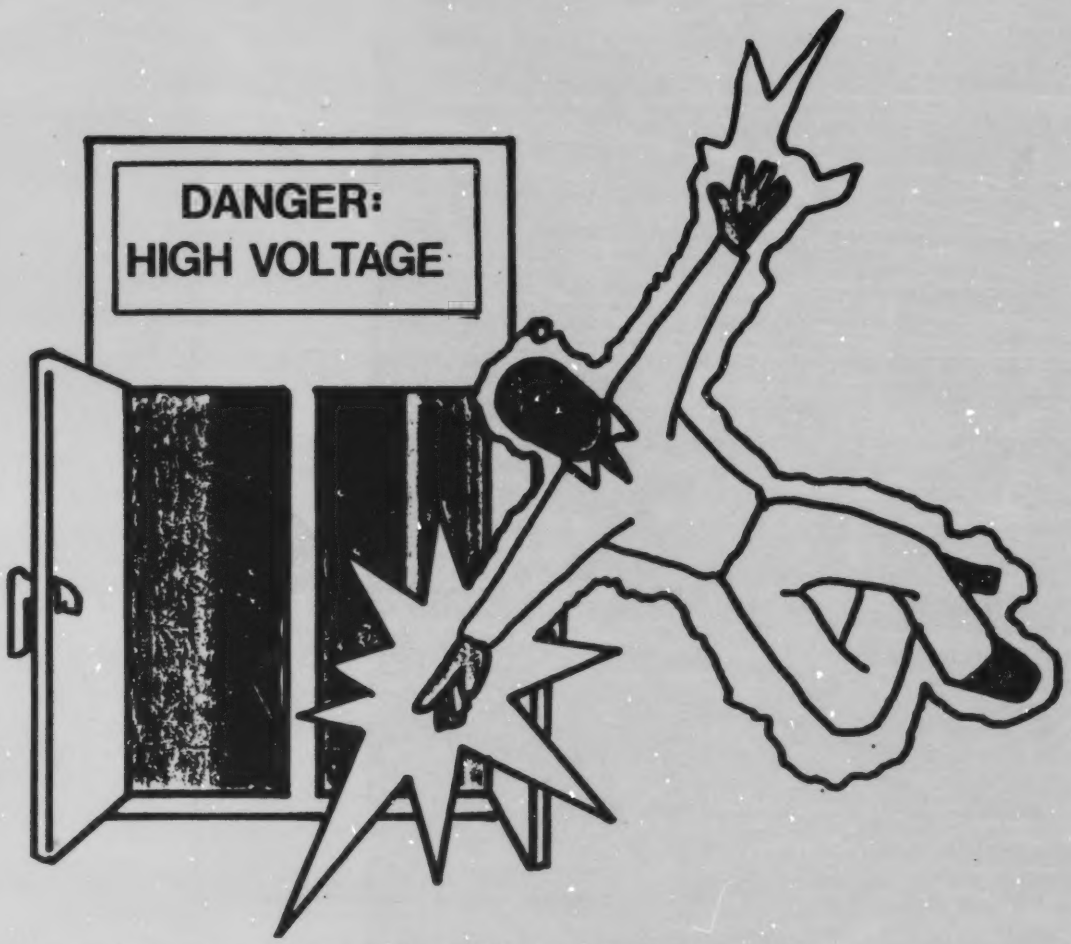
THE POTENTIAL



New technologies make possible interaction

Figure 1-7

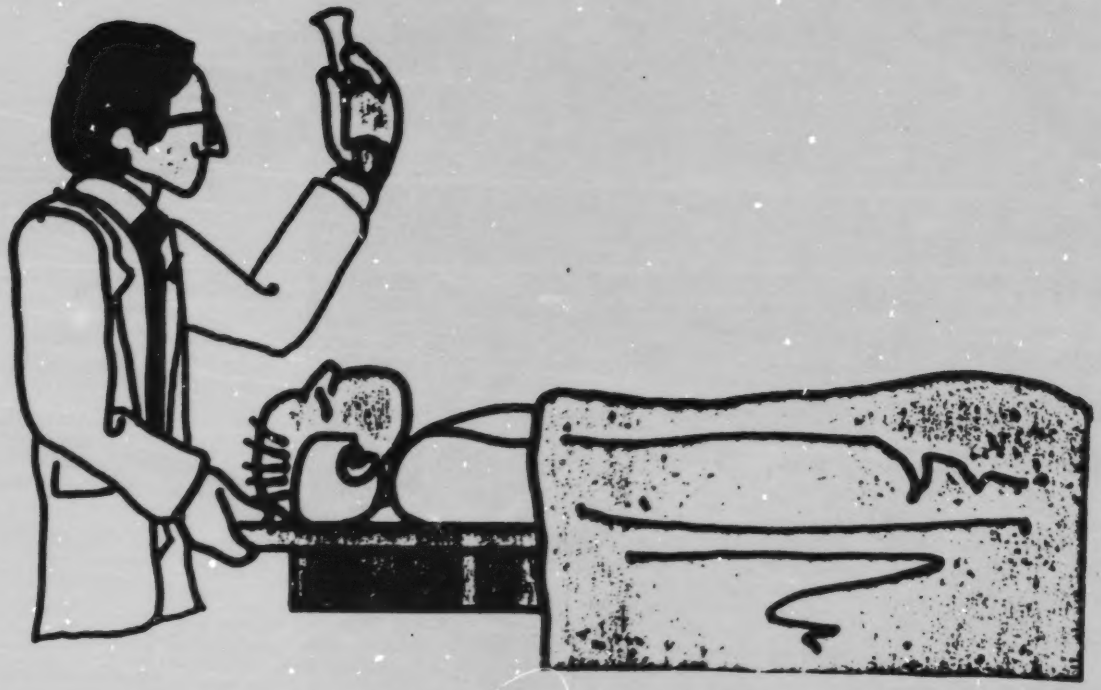
1-9



Simulations for Impossible/Dangerous/Costly Tasks:

Troubleshooting High Voltage

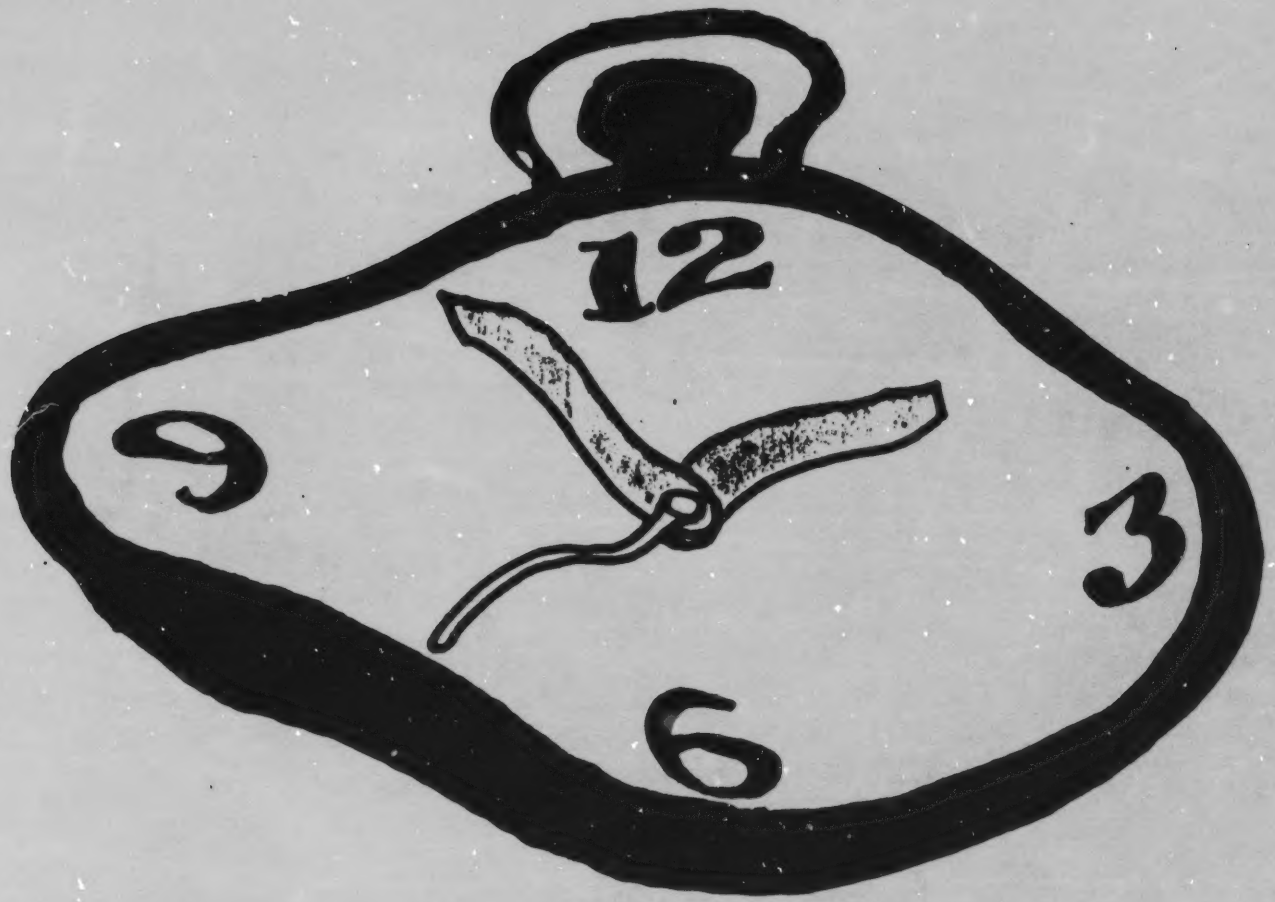
Figure 1-8



Physician Practicing Diagnosis of Rare Diseases

Figure 1-9

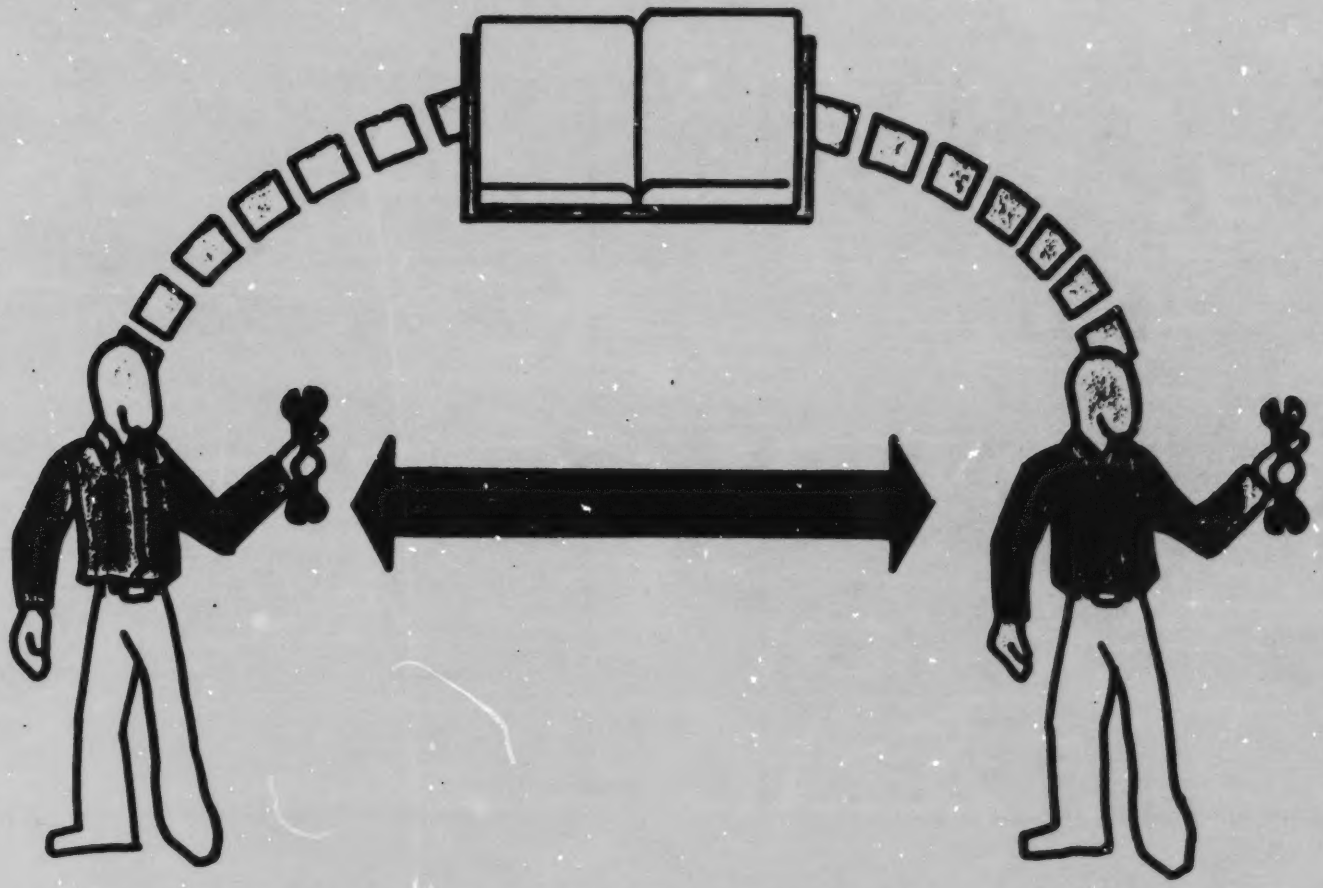
THE POTENTIAL



1-12

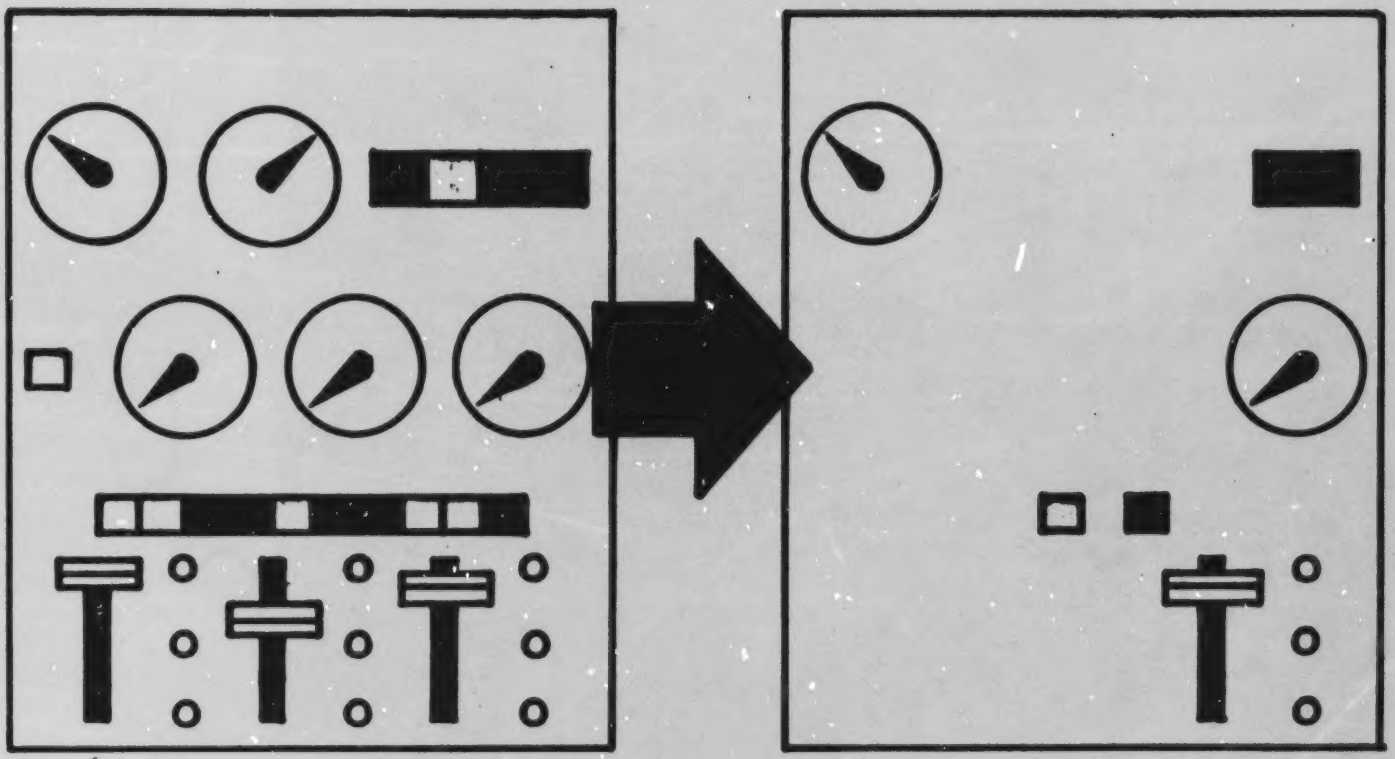
Greater Learner Satisfaction and Performance: Space/Time can be expanded/contracted

Figure 1-10



Teach hands-on tasks directly rather than as head work via books.

Figure 1-11



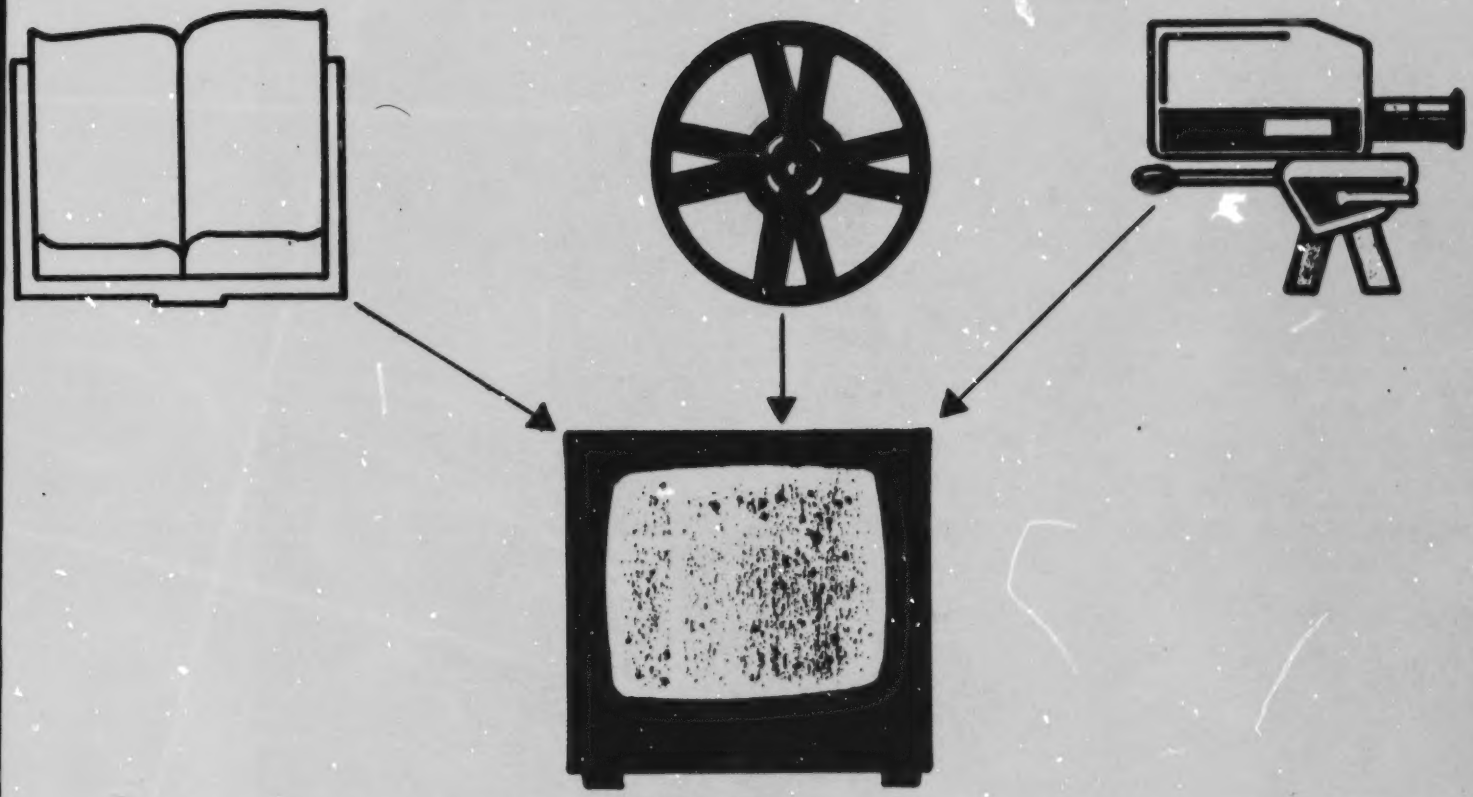
Complexity can be controlled for greater emphasis.

Figure 1-12

THE POTENTIAL

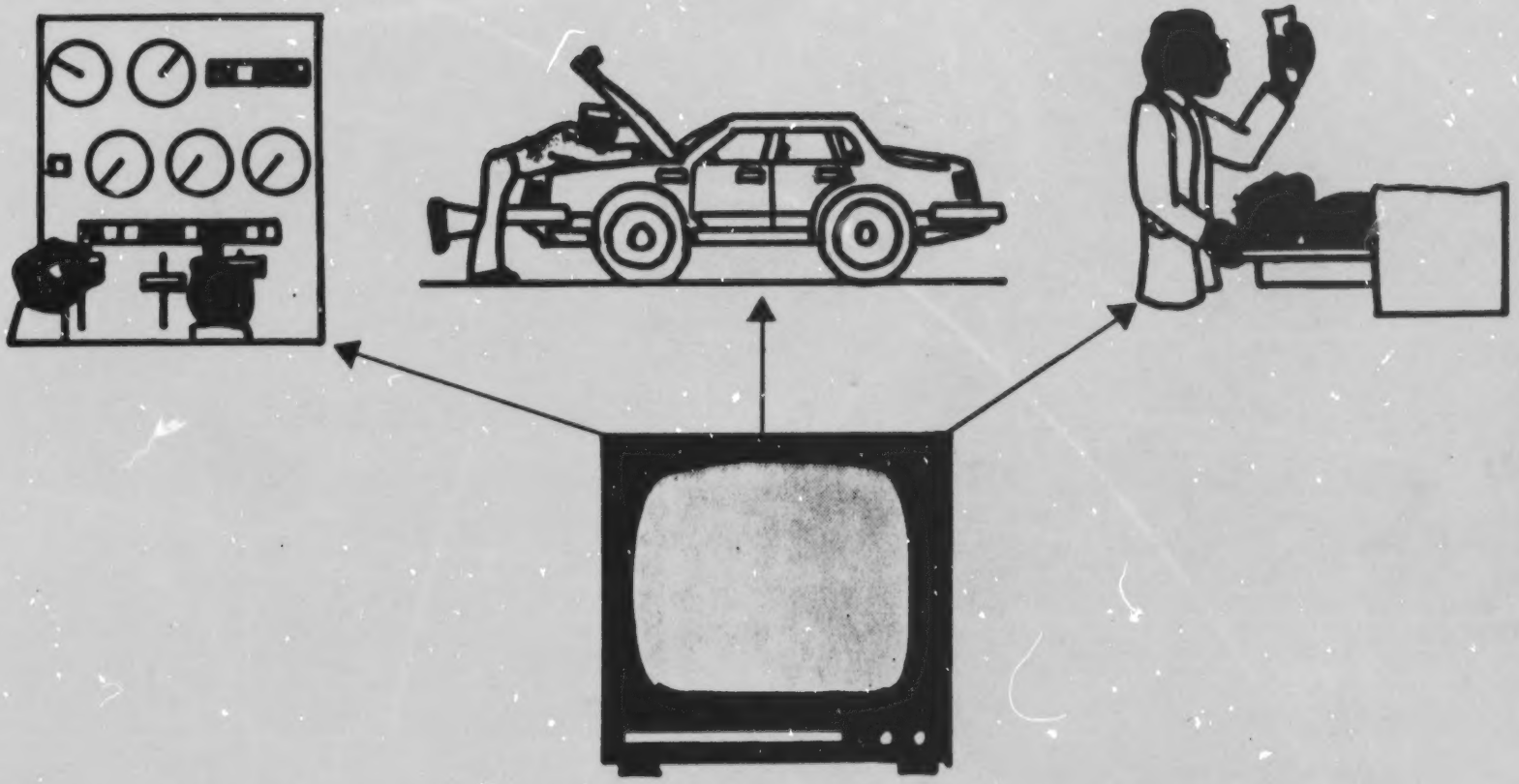
Effectiveness: Results and Feedback Can Be Immediate via simulation

Figure 1-13



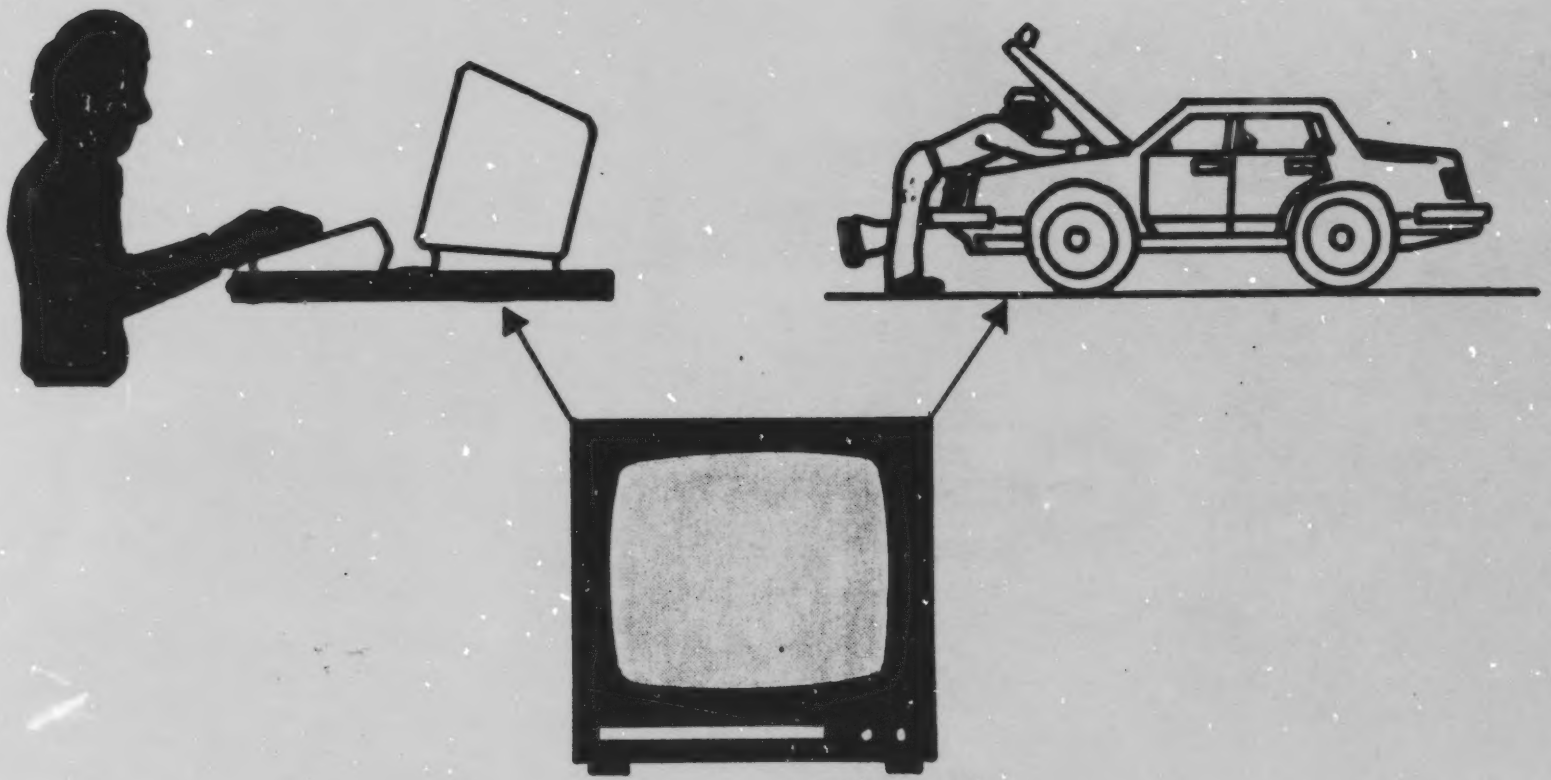
One interactive video system can incorporate a wide range of presentation media.

Figure 1-14



One interactive video system can deliver a wide range of content areas.

Figure 1-15



One interactive video system provides both training and on-the-job aids.

Figure 1-16

The Instructional Development Team

Figure 1-17 presents a management-oriented view of the development effort including the major responsibilities of five team leaders:

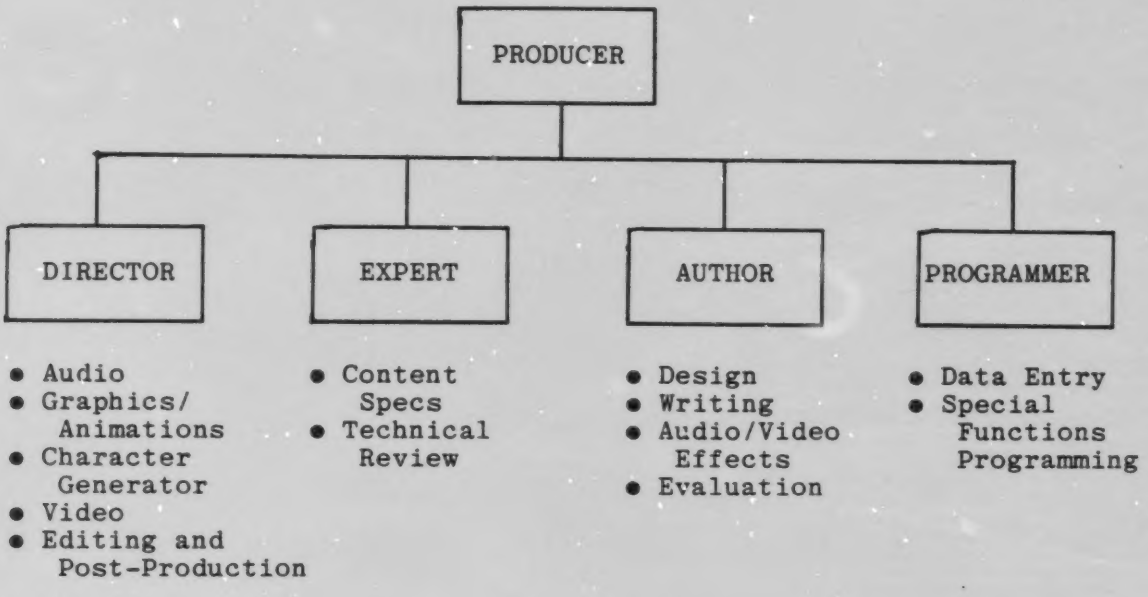


Figure 1-17

Major Responsibilities of Team Leaders

The information in this module is important to the members of the instructional development team for the following reasons:

The producer must orchestrate the work of team leaders like the director, subject matter expert, author, and programmer. Consequently, he or she must assure that the project is governed by design specifications, and know the parameters within which changes and modifications can be made.

As with the producer, the director must have an appreciation of the development context within which the authoring and production occur. This information helps define roles and expectations and provides suggestions for increasing the cost-effectiveness of the process. Additionally, the director contributes an awareness of effective post-production techniques and effects to enhance the interactive learning process.

The subject matter expert requires an understanding of the total development process and how technical accuracy influences the final outcome. This overview also provides a base of understanding for active participation in problem-solving through the authoring and production process.

In cases where the author or writer has not been the instructional developer, he or she needs to know why certain guidelines have been specified and how they control the creative process.

The programmer needs to know the information requirements of of other team members and the total process by which discs are created. This helps the programmer to suggest creative interaction possibilities and to define efficient strategies for authoring in order to facilitate coding.

Each member of the team needs to catch the vision of the creative potential of interactive videodiscs. They must also understand their interdependence in a successful production effort.

Major Steps in Project Planning

The major steps in project planning are:

- Analyze needs, goals, tasks, resources, and performance measures
- Develop objectives, strategy, and management plan
- Select available audio, video, and graphics resources
- Define the delivery system hardware/software
- Determine the mastering specifications

The project planning stage of interactive videodisc development begins with the planning conference involving the producer, the director, the subject matter expert, the author/writer, the programmer, and other members of the production team. The overriding purpose of the planning conference is to allow each member of the production team to grasp the scope of the project and make comments, suggestions, and recommendations. As a result of the planning conference, the combined input may be incorporated into a comprehensive development plan with reasonable time and budget constraints.

Analyze Needs, Goals, Tasks, Resources, and Performance Measures

In order to design the program, the members of the team need to consider the needs and goals of the client and especially any hidden agendas. The target audience must be determined along with the resources available to the project. The job to be performed and the tasks to be trained must be analyzed.

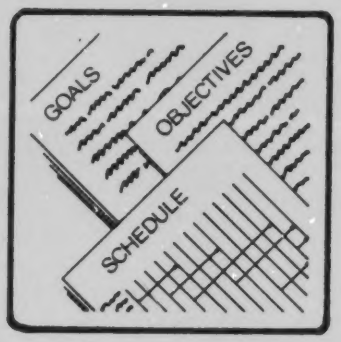
In a simulation, every step must be shown. This forces a tight task analysis. Be careful, however, about two things in an equipment simulation:

- Legends that are legible on the actual equipment may not be legible on video, and thus may not provide cues that are otherwise available.

- Spatial orientation and location of objects that can easily be seen on actual equipment must be carefully designed into video simulations.

One part of task analysis for a procedure might be videotaping an expert performing the procedure. The sequence may be used for both instruction and a job aid, just as a simulation might be used for both practice and testing. Moreover, the entire package can be exported to provide standardized materials.

Develop Objectives, Strategy, and Management Plan



In conjunction with developing objectives, the design team must develop tests, describe entry behavior, and determine the best sequence and structure. These steps constitute phase II (Design) of the IPISD model.

The planning conference is the first opportunity the producer has to provide team members an overview of the final product. At this conference, the director, the expert, and author/writer, and the programmer are present, with perhaps an evaluator (optional). The results of this conference should include decisions about personnel responsibilities and agreement on particular policies concerning the qualities of the finished program.

The exact process, set of topics, and decisions involved in a planning conference depends upon the particulars of your development situation. If extensive planning and design documentations have been created, emphasis of the conference will be upon the design of the message and techniques for presenting it. If such documentation is not available, attention may be given to defining appropriate instruction strategies.

Moreover, the types of decisions and communications necessary during the planning conference depend to a great extent on the group experience, training, viewpoints, and language for communications shared by the members of your staff. Some staffs may find that communications and agreement come slowly. Others find that common understanding and terminology hasten the business of the meeting. Even during the course of one project, the character and length of the planning conference is likely to change.

The instructional development team must specify learning events and activities. This includes specifying the exact wording of objectives, decisions on presentation strategy, practice and test item formats, and types of prompting and feedback to be provided. (This activity corresponds to Block III.1 in Figure 3.) They must also specify the system management plan to show the resources required to implement and run the program. The planning conference must produce decisions regarding when testing is to occur, what instructor and support personnel are to do, and how all these elements are to be monitored. These decisions have implications for some of the characteristics of individual scripts. (This corresponds to IPISD Block III.2.)

Developing Objectives. Development of objectives is affected in an important way because it is now possible through the simulations available on an interactive videodisc to write more objectives requiring job-like performance than was possible in the past. For example, in an electronic maintenance task, the objective may be to troubleshoot a problem within a certain circuit. In the past, the school portion of the training required objectives like "state the procedure to troubleshoot the ---." Using a two dimensional simulation, the objective can be "troubleshoot the ---." This is a remarkable new capability that can significantly enhance training productivity.

Developing Tests. With the integrated training and testing package available on an interactive videodisc, writing item generators and simulations is an important part of writing instruction. Tests can become performance tests in many cases. Moreover, with the computer one can rapidly evaluate the tests and improve them. Generation of test items by the computer or selection of items for a test from a large number of items in a pool can contribute substantially to test security. The computer can automatically score the student's test and provide immediate feedback rather than the six-week to three-month turnaround time commonly required for Skill Qualification Tests. The computer can also be used as a computer-managed instruction system where the supervisor enters scores on performance and essay items.

Attitude questionnaire and supervisor reports can also be added to this data base.

Determining Sequence and Structure. Here the notion of increasingly complex models comes into play. Rather than asking for a verbal approximation to a hands-on behavior, it is possible to begin the student with a very simple version of the actual procedure (termed a work model), then to successively complicate the procedure until it is close to that of the actual job. At the present, course sequencing is largely a matter of sometimes arbitrary decisions about prerequisite skills. By focusing on actual job performance, the sequence of the course can be revised based upon performance of the students in the simulations.

Specifying Learning Events/Activities. Part of determining stragegy in IPISD is to categorize the objectives into a set of eleven categories, each of which uses a prescribed mode of instruction. In essence, the eleven categories provide a set of job aids for authors. These job aids can also be included in a computerized authoring system. Thus for rule learning, pools of problems could be developed for a student to practice. Examples and non-example items could be presented for classification behavior, while for symbol learning the symbols could be paired using mnemonics and standard paired associate learning models. Detection behavior can be enhanced using a simulation or generated items in which the signal is embedded in increasing amounts of noise. Gross motor behaviors can also be trained, at least partly using a two dimensional simulation to demonstrate and model the behavior. For example, a demonstration can be given for cutting a complex pattern on a lathe, by showing the cuts on the videodisc and permitting the student to examine them in slow motion. In this way also the critical features can be highlighted for the student's attention. Finally in the area of attitude learning, a human model can be presented by the videodisc. Modeling has been shown to provide the most effective means of changing attitudes. If necessary, the student can interact in a limited way with the human model on the videodisc by responding to questions, where the human model's feedback on the videodisc depends upon the reply of the student.

Table 1-1 presents eleven graphics guidelines for various types of training objectives. These types relate to those referenced in the IPISD model. Merrill and Bunderson (1980) present these in greater detail.

The Management Plan usually includes information gathering and development of a data base. The computer of the interactive videodisc system may include a computer-managed instruction (CMI) program which greatly facilitates this effort. If so, it should be designed at this point.

Table 1-1

Graphics Guidelines for Eleven Types of Objectives

1. Rule learning and using. The learning of complex procedural rules can be faciliated through the use of representations such as flow charts which graphically portray the order of the operations of the procedure and alternate paths which could be taken at decision points.

2. Classifying. Pictorial graphics should be used as examples of concepts which have concrete referents. In the initial stages of training, simplified pictorial graphics should be used in order to isolate and highlight critical attributes. Later stages of training could employ more realistic graphics in order to facilitate transfer to the real world environment or task.

3. Identifying symbols. Considerable drill and practice with corrective feedback using graphics of actual symbols may be required in order to adequately learn how to identify symbols.

4. Detecting. The training of detecting behavior should involve the presentation of graphics within significant blocks of time and space which are realistic in terms of both the object itself and the natural noise of the environmental setting.

5. Making decisions. Training in decision making should involve instruction in the use and interpretation of various numerical relationships represented in both tabular displays and figural graphics.

6. Recalling bodies of knowledge and using verbal information. A graphical representation of the relationships between various facts and ideas can provide organization and meaning which may facilitate the storage and retrieval of verbal information. Pictures or line drawings inserted in textual, verbal information often have no effect on performance since they only illustrate concepts which could have been readily visualized from the textual description.

7. Performing gross motor skills. The demonstration of a complex motor skill in real time may be too fast. However, slow motion could demonstration the continuity of the movement while permitting critical aspects to be perceived. A videotape of a trainee's motor skill performance may be a very valuable feedback device.

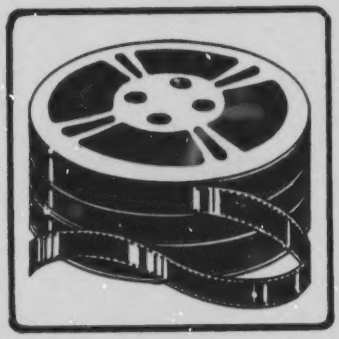
8. Steering and guiding-continuous movement. Graphics used to present the relevant cues for steering and guiding behavior should have a high relationship to real world noise and time conditions in the later stages of training.

9. Recalling procedures, positioning movement. If the procedure to be learned involves the assembly or disassembly of a piece of equipment with many parts, then graphics would be necessary to show the various parts of the equipment and their relationship to each other.

10. Voice communicating. In general, graphics would not be necessary in the training of voice communicating behavior.

11. Attitude learning. Human modeling seems to be the most applicable, and probably the most effective approach for attitude learning. Attitude learning involves the imitation of a credible and respected human model's choices of action. A human model may be presented in several ways: appearing in person, in pictures, in movies or TV, or merely described as in a novel, history text, or biography.

Select Available Video, Audio, and Graphics Resources



One of the prime advantages of the interactive videodisc system is that it permits widely diversified materials to be combined into a single program. For example, if two videotape productions on the same topic use different actors, different equipment, and have different color balance they may still be used in a videodisc by inserting still-frame text and graphic sections between the videotape segments.

The task of selecting from existing materials may involve the director of television production, a video editor, a subject matter expert, and perhaps the writer/author, depending on the kinds of materials available.

The following guidelines may help in selecting available materials:

Step 1 Obtain review copies. These include video, textual, graphic, and other materials that may be used in the production process.

Step 2 Review the materials. Look for:
- relevance to the program
- quality
- availability of originals
- technical accuracy

In this step, the director of TV production will define these characteristics and note the technical feasibility of available materials.

Step 3 Make a list of the usable material. The list should include material that can be used as, is as well as material that will require modification. The director will provide input here concerning technical requirements.

Step 4 Specify location of source material. Indicate on the source materials list where each piece of video, graphics or audio can be found and what will be required to obtain originals of the material. (These activities correspond to Block III.3 of the IPISD model.)

Define Delivery System Hardware/Software

For an interactive video application, you should consider videodisc when the following are required:

- Realistic still pictures that can be viewed indefinitely
- Motion with photo-realism
- Full audio (voice and music)
- Fast (2-5 seconds maximum) random access to either stills or motion

You should consider videotape if the program must meet these criteria:

- Frequent changes to the program
- No stills
- Small number of systems
- Classified material
- No fast random access required

Computer-generated images should be considered for these conditions:

- Continuous modification is required to a graphic image based on user or program input.
- Photo realism is not required.

Videodiscs for classified material will become practical when 3M or others obtain security clearances for their facilities and personnel, or when local mastering becomes available.

Videodisc or tape can be alternated with computer-generated images, and videodisc stills (e.g., of a map) can be combined with computer-generated images (e.g., of targets).

With a flexible delivery system like the interactive videodisc, the issue is not so much which media will be used, but rather how best to use the interactivity and creative possibilities of this new delivery system.

The new technologies have significant implications for how the instructional materials, are developed during story-boarding. Your particular delivery system influences the material since you will write within the capabilities of the delivery system and yet use the system to its fullest extent to provide the types of displays and interactions called for. For example, a computer with text and graphics overlays permits generative items and simulations to be used.

This sometimes requires great creativity on your part -- and a thorough knowledge of the delivery system and video animation/ special effect capabilities. When you discover in planning conferences that your imagination for displays or interactions has out-stipped the capabilities of your delivery system, you may find that knowledge of the system will help you find ways around the apparent limitations to get what you want.

It is useful to distinguish four levels of videodisc player capabilities:

- Consumer videodisc players must be operated manually. A remote keypad may be available to branch to any label which the user must specify. The workbook or folder for the disc must contain frame addresses and instructions. These are also termed level one players.
- More expensive industrial/educational players have a small built-in microprocessor which can read in programs stored in the audio track. A small remote keypad can be used to program

the player or to make menu selections and answer multiple-choice questions which result in automatic branching to different portions of the disc. These are level two players.

- Computer-controlled players have an external microprocessor which gives them considerably more capability and flexibility than the built-in microprocessor. This includes abilities to 1) process constructed answers, whether numeric or alphabetic, 2) keep score and calculate or branch based on the score, 3) provide registration records and management functions, and 4) generate computer graphics and display them either separately or directly over the videodisc image. These are also termed level three players.

- The second-generation intelligent videodisc system has all of the capabilities of the computer-controlled videodisc plus more sophisticated computer image generation and still-frame audio. Still-frame audio is the ability to encode audio in the video frames, not merely the audio tracks. For example, while a single video frame is being refreshed repeatedly, 10 to 30 seconds of audio may be read out of the same or another frame. This system enables the compression of many audio-visual programs on a single disc and enhanced interactivity through the more sophisticated computer graphics. This type is not yet widely available.

It would be unreasonable to expect instructional developers to produce each one of the 54,000 frames without error, and it would also be unreasonable to expect that over a period of several years there would be no changes in operational procedures. Computer-controlled videodisc and second generation videodisc systems have the capability to generate computer graphics or text in the place of outdated videodisc frames, thus minimizing the problem and significantly extending the "life" of the videodisc.

Natural Interfaces

Natural interfaces must be considered along with player and overlay capabilities. Many users will not be proficient typists, nor will most interactive videodisc programs require typing. Instead, keypads with function keys (e.g., HELP, NEXT, GLOSSARY) or touch panels should be used. Voice input may be appropriate for tasks that require voice in the actual environment or where hands or eyes are busy (e.g., for maintenance job aiding). In some cases replica controls like switches and joysticks can be used to provide spatial orientation, tactile cues, psychomotor training, or simply for ease of interaction. Appendix B presents more information selecting and using touch panels. Appendix C presents voice input guidelines.

Sample delivery system components are presented in Figure 1-18 and include:

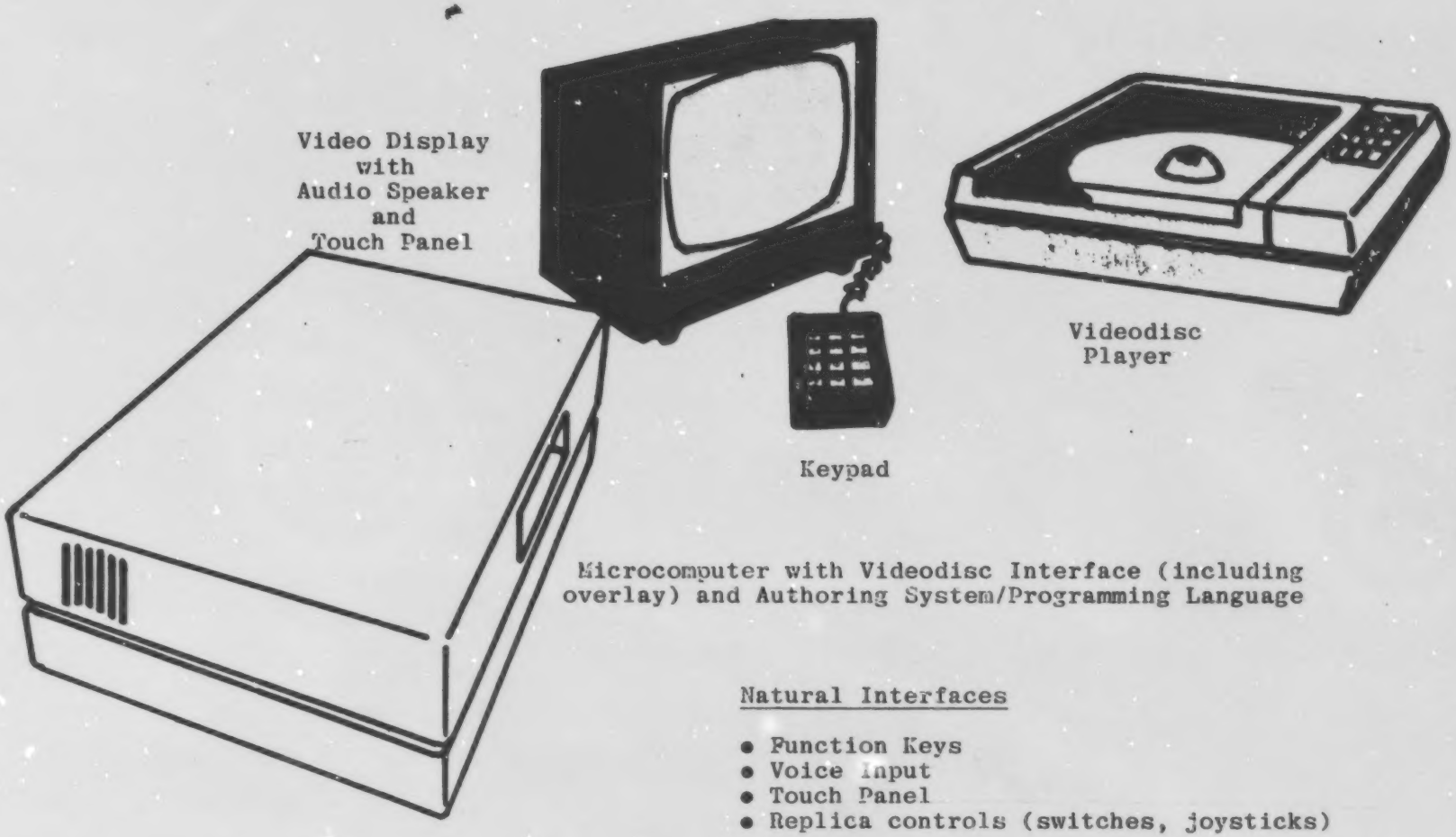
- A videodisc player
- Computer/graphics interface hardware for videodisc control and text overwrite
- User Input Device(s) -- keypad, keyboard, touch panel, joystick, voice, or replica controls
- Video Monitor
- Computer system
- Authoring System/Programming Language

Players

Several brands of optical videodisc players can be used for interactive video applications. These include Magnavox (Philips), DiscoVision, Sony, Thompson CSF, and Pioneer.(1) As of this writing, models marketed under the Magnavision and Pioneer labels are for comsumer use and do not have internal programming. The other brands are industrial/education (I/E) units which include small internal computers to control the player. Using a hand-held unit or front panel controls, the user can (a) manually control the disc, (b) set the frame numbers of certain registers then step through the registers while entering the control commands, and (c) program the disc so that it can run by itself. The small, built-in computer provides varied capabilities to use the disc. Most of these players also offer a plug-in jack for external computer control of the player. The units contain a small character generator to display on the screen (for example, to ask a computer-generated question). Some players have one drawback for computer control, and that is that the commands appear on the screen as they are entered by the computer. This can be quite distracting unless the video is turned off by the interface while the commands are sent.

(1) Commercial designations are provided only for description. Their use does not constitute endorsement by the Department of Army or the Army Research Institute.

INTERACTIVE VIDEO: SYSTEM HARDWARE



Natural Interfaces

- Function Keys
- Voice Input
- Touch Panel
- Replica controls (switches, joysticks)

Figure 1-18

Search time for the industrial/education players is typically three to five seconds, worst case (beginning to end of the disc). For consumer players the access time is usually 15-20 seconds worst case, but consumer players cost about 1/3 as much as industrial/education players. They are not built as sturdily as the I/E players.

To search for a frame on some consumer players, the user must turn on the frame number counter, then watch as the frames fly by until a frame shortly before the one selected appears. The user then advances one frame at a time to the selected frame. On other consumer and all industrial/education players this is automatic, and the user need only give the frame number and the search command to get the frame.

Computer Graphics Interface. In many applications it is important to place computer-generated text and graphics on the video screen, and to overlay these on the videodisc image itself.

Several firms make interfaces that switch between computer and videodisc output. A few provide overlays. These permit the video to be turned on and off, graphics (including text) to be turned on and off, and computer-generated graphics and video to be presented simultaneously as overlays. Most video text overlays are a maximum of 24 lines of 32 characters. All these capabilities are required for generative items in interactive videodisc programs.

In addition, by having the current videodisc frame number available in the microprocessor at all times, the disc and computer program can be kept in synchronization even when the learner is given some control of the videodisc speed and frame accessing.

Video Monitor. A television receiver is not the same as a video monitor. A receiver uses a radio frequency input, while a monitor uses a lower frequency video input plus a separate audio input. The interface usually handles only video signals for video monitors. The audio usually runs straight from the player to the monitor.

Computer System. The computer system to run the videodisc player can be as simple or as complex as required by the application. Using the built-in computer of I/E players, it is possible to program the disc and to accept responses from the student to multiple-choice questions posed by videodisc frames. This type of processing is limited for educational and training applications, and a more powerful computer is required for computer-assisted instruction. Any of the micro-, mini-, or main frame computers used for computer-assisted instruction can be used for an interactive videodisc. For example, WICAT has used the APPLE, Western Digital Micro-engine, DEC VAX 11/780, and our own MC 68000-based system 100 to control the videodisc.

Authoring System/Programming Language. An authoring system can greatly increase productivity for large interactive videodisc projects. Complex programs are easier with an authoring system, and authors can make changes themselves. However, any computer language that outputs commands that can be recognized by the videodisc interface can be used if necessary. BASIC in particular has been used several times. WICAT has modified the machine input/output procedures (MIOP) of the PLANIT authoring language on a DEC VAX 11/780 to control a videodisc. This effort was successful, and led to efforts to put an authoring system on a portable microcomputer. WICAT adapted its own general purpose authoring system for this purpose with several programs.

Sometimes interactive videodiscs require multiple interfaces (e.g., simultaneous touch panel and replica 3D simulator input). These require custom designed authoring systems. A given program tends to require a limited number of interactions and videodisc commands (e.g., to receive and branch on touch panel input, to play a motion sequence, or to write text on the screen). Therefore, the custom authoring system can consist of a few templates and the driver program to execute them. Templates are fill-in-the-blank forms, for example to play a motion sequence. The author specifies the data. For a motion sequence this might include beginning frame, ending frame, speed, which audio tracks will be used, and which template should be executed next. The driver program then runs the program according to the templates. We have successfully used this approach for several simulations and find that some templates are used in many programs, while others are specific to one program. The drivers are always specific. Common templates and the code to execute them can be pulled off the shelf.

Selecting the System

Stand-Alone Players. If you are developing a program for a mass market, then you should consider the most inexpensive delivery system. This will probably consist of a consumer model player with its standard front panel or remote control for input. This simple videodisc delivery system can be both inexpensive and highly effective.

If you are developing materials for a public exhibition on a limited budget or for sales presentations at many locations you should consider an industrial/education videodisc player with built in microcomputer. This system permits you to ask questions of the user and branch depending upon the response. The system can also be programmed to repeat a given program indefinitely, to present still frames for a specified amount of time, and to search to different places on the disc in response to user choices from a menu.

Player With Personal Computer. If you (1) will use the page turning, branching, or linear simulation modes, (2) do not plan to expand to other modes, (3) will use only one input device at a time, and (4) will have a relatively short program so that a full authoring system is not a necessity, you should consider the following type of system:

- Personal computer
- Consumer or industrial/education videodisc player that can easily be put under computer control
- Interface between the computer and videodisc player
- A video character generator with overlay or keying features. This is optional, and may be part of the videodisc interface.

The system above will permit you to control videodisc presentations on the screen, and to switch to computer-generated text and graphics. With the optional character generater/overlay capability, you can combine computer-generated text and graphics with a videodisc image.

The type of system described above is available commercially for as little as $3000. A more common figure is about $5000 to $6000. This type of system can be very effective for the applications described above. It is a relatively inexpensive means to deliver many types of interactive videodisc programs.

Player With Commercial Computer. You should consider using an industrial/education videodisc player and commercial computer if your application tends to fit these characteristics:

- One delivery system will handle the full range of presentation modes from page turning through system simulation.
- The system must handle simultaneous multiple inputs and outputs. Examples are keypad and touch panel inputs, with videodisc and random access audio outputs.
- Long or complex programs will be developed that require a large general purpose programming language or authoring system.
- The application requires a large program and thus more than 64K of random access memory (RAM).
- The system will be linked to or will drive a three dimensional replica simulator.

An interactive videodisc system employing an industrial/education player and commercial computer is likely to cost between $10,000 and $25,000 depending on peripheral components. Custom engineering and software development for special device drivers might increase this cost. Addition of a 3-D replica simulator will greatly increase the cost since it must be hand made and requires special engineering and software development.

As can be seen from the descriptions above, an interactive videodisc delivery system usually ranges from the price of a consumer player alone (as little at $700) to about $25,000. This cost should be compared to the total cost for developing the program, the number of delivery systems to be fielded, the possible trade offs between labor and hardware costs for programming, and costs of alternatives like actual equipment with instructors or 3D replica simulators.

One possible approach to cutting the cost of delivery systems in the field while maintaining the advantages of a full computer authoring system and utilities for production, is to use two separate devices: one for production of software and another for its delivery. This approach has not generally been successful because of the well known problems of developing on one piece of hardware with its capabilities, and delivering on another set of hardware that has different capabilities. Perhaps the most successful application of the dual system approach in education and training is with random access audio using the linear predictive coding (LPC) technique. This technique requires complex encoding hardware and software, but simple decoding hardware and software. In fact, the decoder can be placed on chips, as Texas Instruments has done with their series of hand-held talking learning aids.

The most likely application of the dual system approach for interactive videodisc is to develop a program using a large system, then to store that program in Programmable Read-Only Memory (PROM). Using this approach, the software can be more easily protected from unauthorized copying, and access to the program is usually faster than if it is stored on magnetic disks. Nevertheless, if the program is large it will still need a 16 or 32 bit delivery system computer that can support more than 64K of RAM.

Determine the Mastering Specifications

If not already familiar with them, the director needs to contact the mastering house for requirements for preparing and submitting a videotape for videodisc mastering.

The outcome of this exchange should provide (1) an understanding of videodisc mastering requirements, including specific formats and

equipment which may be used, (2) forms and procedures for submitting tapes for disc mastering, and (3) a list of potential problems to avoid during the production or pre-mastering of the disc.

For example, some videodisc mastering facilities will provide 30 minute discs, while one recommends discs of only 27 minutes duration. Also, when filmed material is being transferred to tape for use on a videodisc, serious trouble may be caused by transfer techniques which ignore the jitter caused by transferring film at 24 frames per second to videotape at 30 frames per second, if you need to stop for still frames during the film segment.

When you contact the mastering facility, there are several questions that should be answered:

How many minutes can be mastered on one side of the disc?

What information do they need from you?

How do they handle program dumps (where the programming is on the disc)?

What kind of post-production work can be done at the mastering facility?

What are the costs for the various services?

What format should be used on the tape sent for mastering (e.g., 1" helical with one minute of bars and tone and one minute of black preceding the program)?

MODULE 2

DESIGN AND AUTHORING

This module is written for the producer and the author responsible for production sheets, and others who will confer in their production -- the expert, director, and programmer. It deals with the procedures and aids used to generate a storyboard to be reviewed and approved for tryout, as well as the process of designing the computer program, conducting the tryout, and making revisions.

We should not be surprised if the first interactive videodiscs are a little like the first movies -- a reflection of current practices, not of the new medium. Until producers and directors realized the power of a new medium, movies were primarily made by pointing the camera at actors presenting a dramatic episode on stage. The possibilities of different angles, cuts, fades, special effects, and non-sequential shooting (followed by editing to place the segments in the proper order) had not yet been explored.

In like manner we can expect the limitations on our vision to be lifted as we explore the possibilities of interactive videodiscs.

Major Steps in Design and Authoring

The major steps in design and authoring are:

- Outline the story and design the course map
- Design the display formats
- Design the computer program
- Draft the storyboard and orientation materials
- Review and revise the storyboard
- Conduct the tryout
- Plan the special effects and animation

This module will prepare you to:

(1) Given the appropriate information, design a course map for the instructional materials that will appear on the interactive videodisc.

(2) Given the appropriate specifications, prepare a storyboard for a lesson or lesson segment.

(3) List the major points of a storyboard review.

(4) Specify the kinds of computer-student interactions required for a lesson you have prepared.

(5) Describe four kinds of video special effects that could be used in your lesson.

Conditions

The following conditions must be considered in describing the procedures for an interactive videodisc:

Personnel. It can be expected that existing authors will produce materials for the new instructional delivery systems like the interactive videodisc. These authors have widely varying degrees of experience and skill in preparing materials. It is recommended that the traditional distinction between authoring and production personnel be maintained. In particular, those who prepare materials for the interactive videodisc do not necessarily need to understand the nuances of videotape production. In fact, since the videodisc combines capabilities of text, motion segments, audio cassettes, and slides, the talents of individuals with experience in each of these areas can be used. Where new motion segments are required, an experienced videotape scriptwriter can be used. Where stills and audio narration will be used together, a slide/tape scriptwriter can be used.

The producer of an interactive videodisc is the one who must creatively develop the new medium. Since the interactive videodisc permits a combination of simulation and computer-assisted instruction with the other elements described above, the producer must be able to assemble and guide a team composed of individuals with experience in widely different facets of instructional technology. Over the course of several years, as the interactive videodisc system becomes more widespread, more individuals will gain the experience necessary to manage the development efforts. While it is reasonable to look to existing personnel for the individual components like videotape scripting and still-with-audio scripting, it is not reasonable to expect to find, immediately, individuals who can creatively utilize the full powers of this new instructional delivery system. Such people will have to be developed over time.

In the meantime, while the full possibilities of this system are being explored, simple procedures and guidelines are in order. These procedures will not necessarily describe in detail how to accomplish a particular task, since in most cases an individual who can perform a specific task is already available. Rather, the procedures are needed to orient the producer to the overall flow, and to describe specific lessons learned, which can save considerable amount of time during the development process.

Equipment. Authoring equipment will primarily consist of pencils, paper, and typewriters. For production, we use a video character generator with external camera inputs to permit

visual frames to be aligned prior to entering the expensive television studio. This equipment is not required for authoring. Naturally, authors will initially make some mistakes in the way they specify the organization of an interactive videodisc, but with experience they can be expected to improve on their performance. Elaborate mock-ups and tryouts are probably unwarranted and too expensive. We recommend that text and graphic production (as opposed to video premastering and mastering) facilities be located very close to the authors. In this way, authors and production personnel can work together to determine the best manner in which to present the materials. In addition, the authors can work with the production personnel to answer questions and review rough drafts as they are produced.

Budgets. The full capabilities of an interactive videodisc need not be exercised in order to gain high economic payoffs. Therefore, it would be unwise to plan on considerable new purchases to support videodisc authoring. In fact, the thrust of our procedures for videodisc authoring is to use what is currently available, building incrementally as the field matures.

The "Costs" section of the Overview and "Selecting the System" in Module 1 present cost details.

Existing Courseware Investment. A tremendous investment of time, energy, and dollars has gone into existing training materials. These materials must be utilized to the fullest extent practical in order to minimize the cost of conversion to a new delivery system. For example, existing slide/tapes and videotapes can be combined in order to rehabilitate old or outdated programs. It is possible to simply take existing programs and transfer them intact into the new videodisc medium. This has already been accomplished by the Army Communicative Technology Office (ACTO), and by WICAT. However, the maximum benefits will probably not come from such basic transfers. Instead, programs must be updated and changed before they can be reconstructed on the videodisc. Generative items can be used to extend greatly the amount of practice available to a student.

Because standard broadcast video is not high resolution, it will not support a large volume of text or graphics on each screen. However, we have found widespread preference by students and reviewers for presenting a single concept, attractively formatted, per screen. The interest level is higher for these single concept pages than for pages that are full of text and graphics. Even when the same material is presented by text on the videodisc, it seems to be less confusing when divided into the single concept format. With print, this approach leads to a large number of pages and unwieldy books. The videodisc permits this powerful reformatting approach to be used easily.

Instructional Strategy. Most authors are used to a particular delivery system or instructional system with which they have worked in the past. When a new technology like the videodisc is introduced, the procedures for the new technology should be couched in terms with which the authors are already familiar. Happily, this is easy to do in the case of the videodisc, since in many cases it is simply an extension of what they are currently using. What is new is the capability to exercise the full range of simulation, motion, audio, and interactive computer-assisted instruction.

Interactive Videodisc Capabilities

The interactive videodisc offers several capabilities that are of use to the author. As explained in the overview, optical videodiscs are of two types: (a) one hour per side of continuous motion (constant linear velocity, or CLV discs), and (b) one half hour per side of combined motion and stills (constant angular velocity, or CAV discs). CAV discs are used exclusively for simulation and most other training because they permit access to individual frames of text and graphics. The remainder of this report assumes the CAV disc. The following paragraphs describe some of the capabilities of this system.

Audio. The standard videodisc includes two channels of audio. Each channel provides a half hour and is part of the same signal as video. Therefore stereo or two languages or one narrating track and one separate track for computer-generated sound effects are possible.

Video Frames. There are three categories of video frames: motion, still, and pause frames. Motion is made up of a series of still pictures shown 30 per second, but sometimes a single image is repeated 30 times per second, and the audio track carries the message. In order to utilize normal audio, the player must proceed forward at 30 frames per second. The video image seen while audio is being played can thus be either a single repeated image or many, producing motion. In essence, the motion is achieved at no extra cost, because the audio is what required 30 frames per second. The capability to store from 2 to 30 seconds of audio in a single video frame (instead of in the 1/30th second audio tracks) is in development.

The still frame is displayed one frame at a time, until the user causes the player to advance.

The pause frame is similar to the still frame except that the system displays the still frame for a predetermined length of time. This allows computer-controlled animation and paced presentations to be used. The pause frame can be a very valuable instructional tool, in that animation can highlight important points and can maintain student interest.

Branching. Coupling the computer to the player allows branching from section to section and within a section. This allows the user to decide whether to review or to skip a section which has

already been mastered. Thus the instruction can be tailored to the personal needs of the user.

Text and Graphic Overlays. One of the drawbacks of current videodiscs is that they are relatively expensive to master and that, like a phonograph record, they cannot be modified after they are pressed. We are just entering a new technology with videodisc. In the future, inexpensive digital photographic systems may supplant current optical and capacitance videodiscs. Then changes would be inexpensive also. In addition, magnetic systems may be marketed which have the same capacity as current videodiscs but can be modified. In the meantime, other means must be used to make updates and corrections. The computer is a natural in this regard, since programs stored on magnetic media can be immediately modified.

If an error is made or if a new procedure requires an update, the computer can generate new graphics, text, or can overwrite an incorrect portion of the videodisc picture.

With a system that permits overwriting by combining the videodisc image with computer-generated text and graphics, responses and new items can be generated by the computer, based on each user's individual input. This feature is critical for many simulations, and it permits generation of huge numbers of problems and exercises. Computer text and graphic overlays greatly expand the capabilities of the videodisc and the computer by synergistically combining them.

Answer Processing. Several problem types can be used with interactive videodisc. Simulations require selection of which action to take, then locating the place and making the correct response. Text types include the true or false format (selection between two alternatives), multiple choice (selection among two or more alternatives), and string matching (recognition of a word, a series of words, or a number that the user must compute). In addition, generative items can be used, in that a random number process generates the parameters of the question, so that a single question can have thousands or even millions of variations.

Record Keeping. Since the computer system is automatically processing the answers, it is little problem to retain those answers to form a record to evaluate the student's progress or the efficacy of the instruction. Record keeping implies the use of a data repository. The records must be stored with the computer, where they can be formatted into reports to aid management of instruction.

Author/Expert Relationships

The actual authoring of the instructional materials can be accomplished with a variety of working relationships. At least three combinations of subject matter expert and author/writer are possible:

- In the expert/author mode, the expert becomes the author, learning instructional development techniques and procedures as needed.

- The author/expert mode of developing instruction requires the author to become knowledgeable enough about the subject matter to write without an expert.

- The author and expert mode, preferred in large technical projects, combines the instructional expertise of the developer with the technical knowledge of the subject matter specialist.

Depending on the project and magnitude of the tasks, you may opt to use any or all of these authoring modes to some extent. For example, the technical skills of a scriptwriter may be required to author video motion segments so that appropriate directions (cuts, pans, fades, close-ups, etc.) appear in the storyboard.

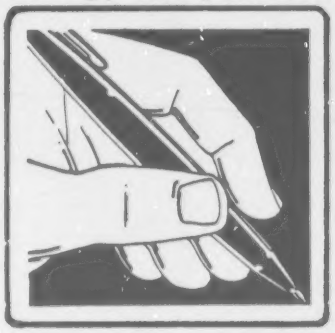
We have found that two people can successfully carry an entire videodisc production through from authoring up to the video studio. Obviously this is an unusual case, but the point is that one person may be able to assume several of the roles presented herein. In addition, a number of reviews can occur informally in small projects. These reviews may be brief and may occur while work is in process, but if they are skipped the result will be very expensive remakes while the work is done over.

The author and expert are heavily involved after the storyboards are authored, so their time must be planned accordingly.

Design the Course Map

First the basic thread of the presentation is developed, and videodisc time allocated to each section.

For a simulation this may be different procedures or situations. For a catalog it may be the introduction and index, followed by sections for different items. For a course it may be an orientation, then alternating problem exposures, teaching, and practice.



A course map details the components of the instruction. This document usually consists of a graphic representation that shows such elements as:

- Registration
- Reports
- Sign on/off procedures
- Introduction/overview

- Help frames/how to use the system
- Executive Summary
- Main instruction/simulation sequences
- Auxiliary information segments
- Glossary or other references sources
- Quizzes/exams
- Games
- Job Aids

Figure 2-1 presents a sample course map for a biology videodisc.

Design the Text and Graphic Formats

The graphic resolution, use of chroma keys, choice of type style and font, the position of titles and headings, and the placement of text and visuals on the screen can be determined in the authoring stage. Decisions made at this point in the development of the project are reflected in the production sheets and thus ripple down through all of the stages that follow.

Any effect requiring video studio work should be reviewed because of the very high costs involved. Also, decisions about number and style of hand drawn graphics have high cost implications and should be reviewed. Decisions about maximum number of graphic elements in one video frame should be made in consultation with a video studio and should involve some on-camera tryouts. In general, video graphics will have lower resultion and must be lower contrast than print graphics. Many colors produce chroma crawl in combination with other colors, and these should be limited or avoided. Bright colors that are attractive when viewed briefly can become annoying over long periods, so choose less intense backgrounds.

In practice, 12 lines of 30 characters is about the maximum text per frame. A graphics designer can help with font

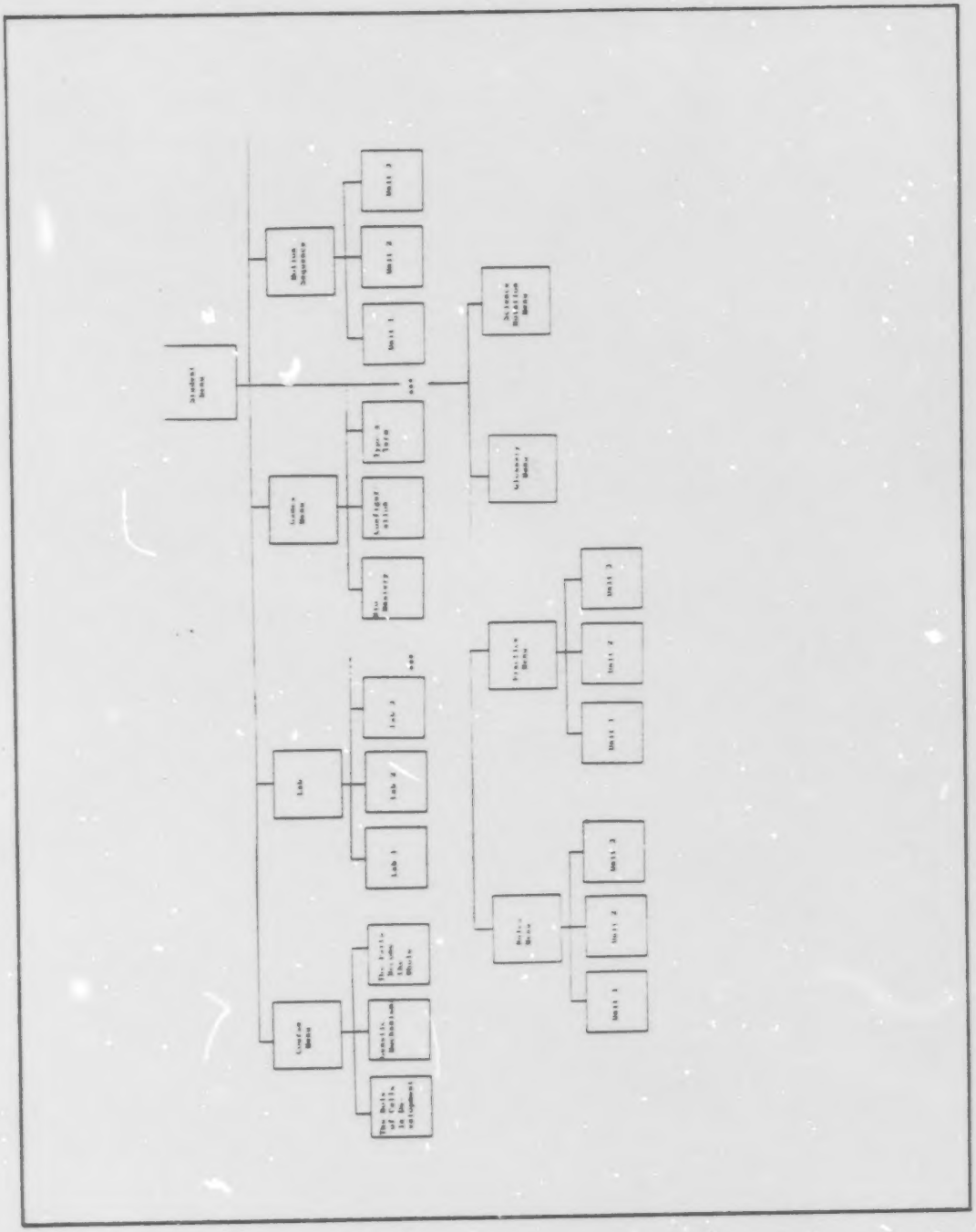


Figure 2-1
Sample Course Map for Biology Videodisc

selection. All graphics should confirm to the TV aspect ratio (ratio of width to height).

If a touch panel will be used, reserved areas on the screen must be defined. These are generally at the bottom of the screen and permit the user to select options such as setting a simulated control or existing the program. If these are used, graphics and text must not intrude in the space, and other touch panel choices should not come close to the reserved areas. Touch locations should be no closer than about a finger width (2 cmm).

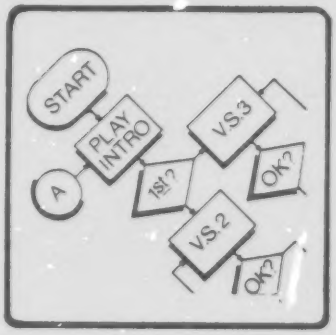
If a keypad will be used, the function keys and their layout must be determined.

Design the Computer Program

Software Specifications

Most beginning developers of interactive videodiscs first author the program, then shoot the video, then master, and only at the end design and write the computer program. Unless the program will be very simple this is a mistake. The software should be designed before authoring begins. Each of the modules to be authored and each of the functions to be programmed should be agreed upon and specified. If you are using an authoring system you must write within the bounds of what it can deliver. For example, most authoring systems do not handle touch panel input.

In order to design the computer program, the programmer must examine the functional specifications regarding hardware user inputs, the course map, screen formats, response time requirements, report structures, etc. Algorithms are then designed to meet those specifications. The emphasis of this module is to specify what the functions do; it is the programmer's responsibility to determine how they are done. However, well-written specifications will greatly facilitate the job.



The computer program design is specified first in the User Requirements. These present from a user's viewpoint the software functions required. Next a set of Functional Specifications are prepared by the designer and programmer. These include templates (if used), screen displays and flowcharts, each major software component, driver functions, user interaction protocols, and a scenario from logon to logoff. Walking through the scenario almost always turns up overlooked software requirements.

Time spent on the functional spec is highly leveraged: one hour in design can save days of coding. Moreover it gives the author an agreed-to track to run on so there are fewer surprises for the programmer when the author finishes writing.

One reason the software specs are so important, and why they should be done before authoring, is that authors and programmers rarely speak the same language. An author might specify a range of video special effects that would cost tens of thousands of dollars in the studio, when the video director could provide much less expensive alternatives. Similarly the author might assume a certain software capability throughout the program that would be outrageously expensive to develop, when something else might be available off the shelf and work even better. Even though author/programmer discussions may be difficult, it is critical that the software functional specs be written and agreed to before authoring begins.

We have found it more efficient in a first production to concentrate on the central instruction/simulation than to include elaborate files, reports, and user options. These can be included in later productions after the first production is a success.

Specific interaction may include the following functions:

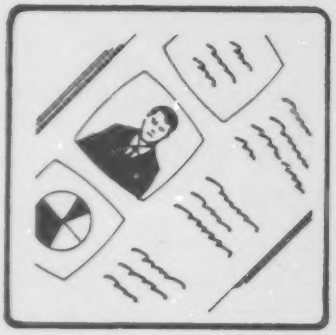
- Description of keypad and function of each key or touch panel
- Types of question and answer processing formats, including multiple-choice, fill-in-the-blank, true/false, and generative
- Feedback for practice items, test question, etc., including videodisc frame versus computer generated frame information
- Screen formats
- Echo response features
- Options for segment types, including stills, motion, and menu pages

Besides these student interactions, another set of functions may be specified for the instructor or manager of instruction. For sophisticated instructional systems, this may require a registration package that handles student sign on/off, student information, course assignments status, and update capability. In addition, instructors may need to access student records, make assignments, specify courses (units) of study, and update files.

Consistency is the key to a successful design. We would hope to say "this key always does this," and provide algorithms for any exceptions.

Draft the Storyboard and Orientation Material

At this point you have a fairly good idea what the program will be. You should adopt, adapt, or create production sheets. These can be:

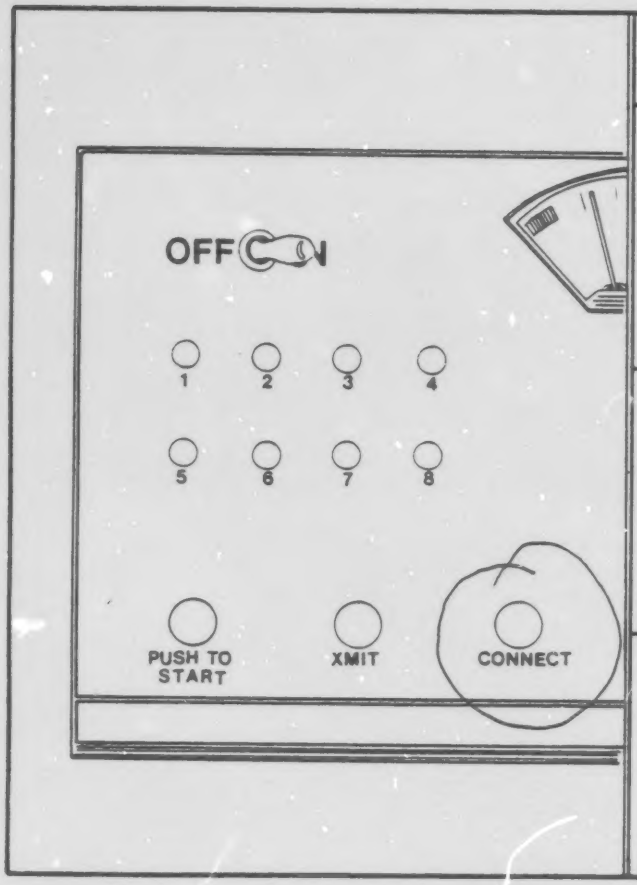


- Storyboards
- Printed pictures of equipment where you indicate what action is to be taken by the user in a simulation
- Lists of frames and motion sequences from existing materials
- Computer templates that control a motion sequence, still frame, user input, etc.
- Scripts or any other format or aid that will save you time

Figure 2-2 presents a sample production sheet like those used by the Ft. Gordon videodisc/microprocessor team for linear equipment simulations. When the user touches the circled control the program will advance to the next logical videodisc frame. To create the program the author indicates on successive sheets the sequence of student actions. Each sheet corresponds to a videodisc still, and can therefore be used as both the shot sheet for video production and the data for programming.

For the following example of an instructional sequence, we will use expanded storyboards written on production sheets, together with keyboard answer processing templates.

Authoring the storyboard/script can now begin.
The interactive videodisc requires more than a conventional storyboard. This expanded storyboard is written on production sheets which carry not only the main message line, graphics, and audio, but also have preduction information. The following example presents factual information in a story format. If you are doing a linear simulation with no audio, you can use a much simpler format with lists or pictures of each control or indicator in turn, as is presented in Figure 2-2.



Segment: _____ Frame Number: 2178

Video Description:

Student Response:

Program Instructions:

Previous Frame: 2177 X Coord. 32

Next Frame: 2179 Y Coord. 16

Figure 2-2. Sample production sheet for a linear equipment simulation. (Adapted with permission from those used by the Ft. Gordon videodisc/microprocessor team.)

A production sheet designed specifically to be used in the authoring of interactive videodisc storyboards is shown in Figure 2-3. This form contains space for relevant data which must be recorded before, during, and following the studio production of a videodisc master tape. In the course of this module and those that follow, you will see where and when these data are entered and what purpose they serve. Note that the storyboard, consisting of a visual and narration script, is written on a production sheet. It is important to watch time allocation so time does not expand beyond the 27 or 30 minute disc capacity.

Storyboard Authoring

The storyboard is one portion of the production sheet. In writing the storyboard, the author will find it awkward and overly time-consuming, perhaps impossible, to fill out one production sheet completely before going on to the next. This is an inefficient way to proceed during scriptwriting. The alternative is the stepwise process in which the sheets grow in stages to fully written and documented storyboards as described below.

Step 1 Write the main message lines. The planning conference will have produced a plan for the author to follow in writing the script. This may call for expository presentations, elaborations and demonstrations, followed by simulations, quizzes, reviews, and other forms of practice. Once these different functions are laid out in the course map, the author may begin to write the main message lines for each unit. For motion sequences these form a script that can be easily reviewed and changed.

The main message line may consist of the information the student must recall for problem solving and the verbal statement of the procedure to use. The main message line for each objective should be written in a running narrative format just as the student will receive it.

The varieties of practice which follow the main message line are dependent upon it and most often cannot be used well without it. Therefore, a complete, appropriately-stated, and accurate main message line is one of the most important parts of the script. This is true whether the script is highly-sequenced and intended to be presented from first to last, or whether the script is meant to be used in small chunks chosen in various orders by a computer routine or by the student.

The product of this step will be a series of production sheets containing the main message line.

Figure 2-2
A Sample Production Sheet

Production Sheet No.___

Lesson_____Segment_____SMPTE ( )__ __ __ __to__ __ __ __

Char. Gen. Cartridge_____Page_____

Estimated Time (seconds)_____

GRAPHICS_____Art__Photo__Prop__No.___

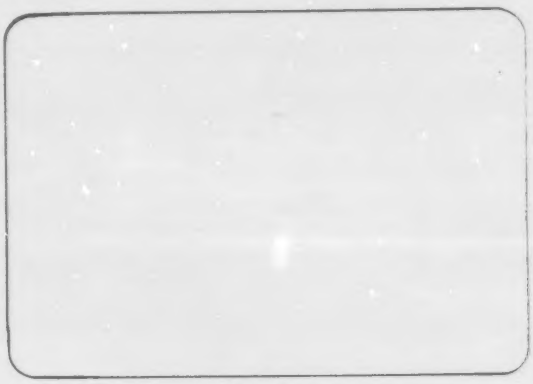
VIDEO_____Still__ Motion ( )__ __ __ __to__ __ __ __

CHARACTER GENERATOR_____External__Text__Animation__

STUDIO_____Highlight__Split/Wipe__Quad__Window__

PROGRAM_____Stop__Pause__Computer Generated__

Calc. Videodisc Frame No._____Actual Videodisc Frame No._____



AUDIO 1:_____

AUDIO 2:_____

Step 2 Determine the rate of presentation. As the author writes the script, there must be a conscious plan so that the rate at which new ideas are introduced is compatible with the student's capacity.

When a delivery system includes a videodisc, particularly, one under computer control, the possibilities for adjusting the rate of presentation of the message are enormous. Some schemes place this control in the student's hands. Others require that the scriptwriter judge the student, determine the appropriate rate of presentation, and insert stops, reviews, etc., wherever it is felt they are necessary.

Step 3 Specify breaks. Breaks will occur more or less automatically as the main message line is put onto the production sheets. A new production sheet should begin for any of the following reasons:

- Major changes in the visual. (This includes additions to or deletions from the screen.)
- Menus, questions, review options, etc.
- Inserted program stops.

Note

- Numbering of production sheets is in increments of 5 or 10 since other pages will be inserted in subsequent passes.

Step 4 Decide audio or visual. As you divide the text where you have placed breaks and put each portion on its own production sheet, you must decide whether the main message will be carried by the audio or by the visual.

The use of audio with an interactive videodisc is presently its most limiting characteristic. Videodiscs allow only 27 to 30 minutes of audio per track. With ingenuity, most of two tracks can be used. Figure 2-4 presents some possibilities. The questions, then, are: When do I use audio? and How can I use it to the greatest advantage?

Table 2-1 presents guidelines for when to use audio in instruction.

Table 2-1
USE OF AUDIO

- Realistic voice or other sounds are required for many kinds of modeling, where the objective is to change attitudes or illustrate a procedure by presenting an expert.
- Sounds are required to make certain discriminations (e.g., between a motor running smoothly or roughly).
- Non-voice sounds (e.g., penny arcade games) can add excitement and motivation to simulation.
- Audio permits communication when the user is away from the terminal or looking elsewhere (e.g., at a simulator while fixing something).
- Audio is helpful to poor readers, and audio redundant with text is preferred by some who can read.
- Extensive voice presentation slows down and paces the man/machine interaction.

One way to expand the amount of audio is to use both audio channels on the videodisc. Of course lip sync is not possible because the same visual image is simply replayed when audio begins on the second channel. The "Call for Fire" videodisc, produced for the Army Research Institute, illustrates this technique. In this case, exact matching of lip movements was not as critical as hearing different exchanges between individuals and conserving disc space.

Video	Motion	Motion	Motion	Stills	Motion
Audio 1	Language A	Stereo Channel A	Narration	Silent	Narration A
Audio 2	Language B	Stereo Channel B	Sound EFX / Silent	CGI Narration	Narration B

Note: The disc must be playing 30 frames per second (fps) to obtain audio. However a computer-generated image (CGI) can be presented with videodisc video turned off and audio playing for narration or random access sound effects (EFX).

Figure 2-4. Relation of Video and Audio for Videodisc Players Without Still Frame Audio.

Step 5 Specify visual requirements. During this pass, you sketch or write the visual and specify the arrangement as it will appear on the screen. Table 2-2 can help in choosing the appropriate use of color. Table 2-3 presents guidelines for the use of motion, while Table 2-4 presents guidelines for using realism. Table 2-5 presents guidelines for the use of visual elements.

Table 2-2

USE OF COLOR, SHADING, AND GRAY SCALE

- Color can increase both immediate performance and retention in comparison to a monochrome presentation.
- Learners appear to take more time assimilating color information than monochrome.
- The above may explain why available research indicates that color has no consistent effect across all learning situations: Color is better for self-paced materials but not for fixed paced, for stills but not for motion, and for high aptitude learners but not for low aptitude.
  --Learners must be given sufficient time to assimilate color. If they are, performance is usually better than with monochrome. If they are not given sufficient time, performance appears to be worse.
  ---Overall, the rate of achievement gain over time is equivalent between color and monochrome.
- Color is required when the task demands color discriminations.
- Color coding is very productive for highlighting and distinquishing portions of displays (e.g., one level of depth in a 3D graphic) or type of content (e.g., A set of rules).
- Color video capability permits use of existing color materials, usually without reformatting.
- Most students today expect color and prefer it over monochrome; it may thus have a motivational advantage which can decrease attrition.
- If gray scale is used in computer generated displays, four levels are the most required, and usually two or three levels will suffice.

Table 2-3

USE OF MOTION

- The available research studies indicate that the effect of motion depends on the purpose, the content, and other factors: Procedures involving a critical demonstration of actions over time are best presented with motion. Spatial concepts are best presented with stills.

- Human modeling to change attitudes often requires motion.

- Motion capability permits use of existing motion materials. It is easy to transfer from 16 mm film or from video to videodisc.

- Motion sequences typically do not allow self pacing. Care must be taken not to present information so fast that the learner cannot process it well. Speed should be slowed down or under user control to demonstrate motor skills.

- A high proportion of motion in existing films is non-relevant (stills).

- Stills with audio are often as effective as motion with audio.

- Animated graphics can help to visualize and clarify processes of many kinds, and are especially useful in simulations.

Table 2-4

USE OF REALISM

- Meaningfulness of visual elements is more important than realism--hand sketched line drawings that highlight critical points can be as effective as detailed colored pictures.

- Realism must be matched to the learner's experience,

  ---The learner who is new to a subject needs simplified presentations (e.g., line drawings). More experienced individuals need a replica of the complexity of the actual situation.

  ---Optimal realism may change as the learner grows more proficient.

  ---Too much detail at first can impede learning by obscuring the critical points.

  ---Too little detail for persons experienced in the content may not give them real world experience in finding the critical features on their own.

- Realism must be matched to the method of presentation.

  ---Students need time to process complex visuals.

  ---Realistic drawings and photographs are most effective for self paced instruction (like that available on electronic delivery systems), where the student can study the materials as long as needed.

  ---Simple line drawings are best for externally paced instruction (like videotape), where sufficient time may not be available for all students to process the information.

- The functionality of the presentation, not its replica nature is what counts.

- A sequence of increasingly realistic, complex or difficult experiences may be optimal.

  ---An example is use of the graduated length method in skiing, where the learner progresses from simple to use, short skis to regular length skis and steeper hills.

- Pictorial realism with color and motion is usually preferred by students.

- Pictures can facilitate learning from text.

- Multimedia presentations may reduce attrition by maintaining student interest.

  ---Caution: A motivational learning experience followed by a boring job will not reduce turnover.

Table 2-5

USE OF VISUAL ELEMENTS

- For procedural instruction, text plus illustrations is better than either by itself.
- Users differ in visual literacy. Complex charts and graphs require more experience than simple pictures, so visual elements must be matched to user abilities and experience.

Once audio and visual decisions are made, they should be described in the production data area of the production sheet. Examples of filled-out data areas can be found on the production sheets in Figure 2-5. Notice that visuals and the instructions combine to describe the desired effect.

The drawing is used to suggest to the production group the visual effect desired for the accompanying text. The drawing need not be made by the author. It can be a copy from another source.

Some applications may require a formal drawing. On the other hand, if the author can use still figures effectively to create a general structure for the visual and give an overall impression, that may be adequate. The production team and their need for information must determine this based on availability of authors for consultation and review of graphics during production.

Figure 2-5

Samples of Graphic and Visual Specifications on Production Sheets

Production Sheet No. 1

Lesson 3.1 Segment A SMPTE ( ) __ __ __ __ to __ __ __ __

Char. Gen. Cartridge _____ Page _____

Estimated Time (seconds) _____

GRAPHICS _____ Art __ Photo __ Prop __ No. ___

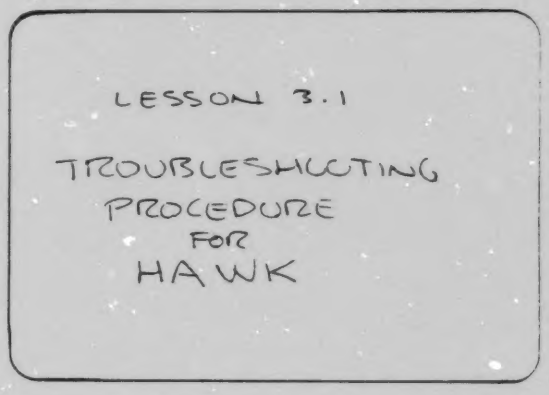
VIDEO _____ Still __ Motion ( ) __ __ __ __ to __ __ __ __

CHARACTER GENERATOR STANDARD LESSON TITLE PAGE External __ Text X Animation __

STUDIO _____ Highlight __ Split/Wipe __ Quad __ Window __

PROGRAM _____ Stop __ Pause __ Computer Generated __

Calc. Videodisc Frame No. _____ Actual Videodisc Frame No. _____



AUDIO 1: WELCOME TO A LESSON ON THE TROUBLESHOOTING PROCEDURE FOR HAWK MISSLE BATTERY MAINTENANCE

AUDIO 2: _____

Figure 2-5 continued

Production Sheet No. 2

Lesson_____ Segment____ SMPTE ( )__ __ __ __ to__ __ __ __

Char. Gen. Cartridge_____ Page____

Estimated Time (seconds)_____

GRAPHICS_____ Art__Photo__Prop__No.__

VIDEO_____ Still__ Motion ( )__ __ __ __ to__ __ __ __

CHARACTER GENERATOR LARGE FONT External__Text X Animation__

STUDIO_____ Highlight__Split/Wipe__Quad__Window__

PROGRAM_____ Stop__Pause__Computer Generated__

Calc. Videodisc Frame No._____ Actual Videodisc Frame No._____

SYSTEMATIC PROCEDURE FOR TROUBLESHOOTING

AUDIO 1: THIS LESSON WILL GIVE YOU AN OVERVIEW OF A SYSTEMATIC PROCEDURE FOR TROUBLESHOOTING.

AUDIO 2:

Figure 2-5 continued

Production Sheet No. 3

Lesson 3.1 Segment A SMPTE ( )__ __ __ __to__ __ __ __

Char. Gen. Cartridge_____ Page____

Estimated Time (seconds)_____

GRAPHICS_____Art X Photo__Prop__No.__

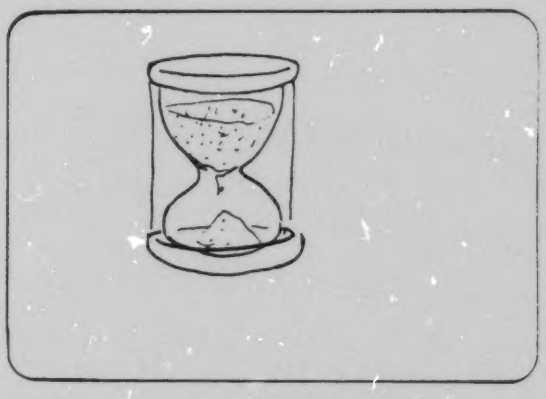
VIDEO_____Still__ Motion ( )__ __ __ __to__ __ __ __

CHARACTER GENERATOR_____External__Text__Animation__

STUDIO_____Highlight__Split/Wipe__Quad__Window__

PROGRAM_____Stop__Pause__Computer Generated__

Calc. Videodisc Frame No._____Actual Videodisc Frame No._____



AUDIO 1: HUNDREDS OF HOURS ARE SPENT IN MAINTENANCE, AND IF THE PROCEDURES USED ARE UNSYSTEMATIC AND SLOW, THAT NUMBER GOES

~~AUDIO 2~~: UP, AND COSTS GO WITH IT.

Step 6 Coordinate the audio and visuals. As visuals are determined, it is important to review the audio and visuals together to ensure that they complement each other. Pauses may need to be inserted in the audio to allow study of the visual. Synchronizations of the audio with visual effects may be desirable, or use of the audio to emphasize points in the visual may be required.

Step 7 Specify branching, generative CAI, stops, and other programming instructions. Depending on the nature of the delivery system, you may be able to build in a variety of instructional interactions which allow the learner to adjust the rate of presentation, repeat a segment, choose options, etc. You may also create review and practice opportunities, insert cues or questions, or draw attention to specific portions of the message.

The "Diagnostic Challenges" videodisc on gastrointestinal disorders developed for Smith, Kline and French Pharmaceuticals is a good example of interactive programming. Branching in this videodisc allows a learner to view a motion segment featuring an interview with the patient, to get a lab test report, to see the results of a treatment, or to review the case history simply by pressing the appropriate buttons on a keypad.

When branching instructions depend upon the student's choice or answer, an answer processing sheet must be used to record the branching instructions for each option. This is one type of authoring system template.

Figure 2-6 presents a typical menu choice, while Figure 2-7 presents one type of answer processing sheet. The details of branching specifications will depend on the authoring system you use.

Step 8 Add "roadsigns" to the script. Roadsigns are the frames put into the script to keep the student oriented. Roadsigns are not part of the instructions themselves but are inserted where necessary to allow the student to recall where the lesson has been and where it is going.

Notes

(1) Frames can easily be added after the initial draft of the storyboard if the draft is numbered by 5's or 10's.

(2) In Figure 2-7 there is no feedback because choices branch directly to the sheet specified.

(3) Branches are to templates.

Step 9 Write practice frames. Practice materials should be written according to the specifications agreed upon at the planning conference. These frames should then be placed on production sheets with appropriate instruction for display creation through videodisc or computer means. Feedback messages can be computer generated or they can appear on videodisc frames.

Step 10 Write test items. These questions differ from quiz or practice items by the absence of feedback for each response. Typically, the student receives an update following the entire set of items which provides pass/fail or remedial information. If computer-generated problems are used (e.g., by randomly placing a marker overlay on a videodisc image of a map and asking for grid coordinates), the same generative procedures used for practice items can be used for test items.

User Orientation Material

The learning medium that the interactive videodisc provides requires an orientation for first-time users. If this orientation material is included on the disc, separate storyboards will need to be prepared for each segment.

Orientation materials may include such things as how to operate the system, what different keys or touch locations will do, different approaches for using the disc, and any other overview-type material that is not directly treated in the instructional protion.

Figure 2-6

Production Sheet No. 117

Lesson_____Segment____SMPTE ( )__ __ __ __to__ __ __ __

Char. Gen. Cartridge_____ Page____

Estimated Time (seconds)_____

GRAPHICS_____Art__Photo__Prop__No.__

VIDEO_____Still__ Motion ( )__ __ __ __to__ __ __ __

CHARACTER GENERATOR_____External__Text__Animation__

STUDIO_____Highlight__Split/Wipe__Quad__Window__

PROGRAM_____Stop__Pause__Computer Generated__

Calc. Videodisc Frame No._____Actual Videodisc Frame No._____

WHICH STEP DO YOU WANT TO SEE?

1. SYSTEM VERIFICATION

2. SIGNAL FLOW DIAGRAM

AUDIO 1: TYPE THE NUMBER OF YOUR CHOICE AND THEN PRESS NEXT.

AUDIO 2:

Figure 2-7

Answer Processing Sheet

Answer processing for frame no. 117

Feedback given via: ☐ videodisc ☐ computer

Choice: 1

Feedback: —

comp. page

On condition 1 branch to 11

Choice: 2

Feedback: —

comp. page

On condition 2 branch to 56

Choice

Feedback:

comp. page

On condition branch to

Choice:

Feedback:

comp. page

On condition branch to

Choice

Feedback:

comp. page

On condition branch to

Comments: * "N" refers to a press of the NEXT key

Review and Revise the Storyboard

The next task involves critical and technical reviews by the subject matter expert and the director. Changes at this point in the development are easy and inexpensive to make and will save considerable editing in later stages.

Here is a suggested procedure for the reviews:

Step 1 The subject matter expert reviews the draft storyboard watching for technical inaccuracies in terminology, procedures, vocabulary, acronyms, and definitions as well as the content of visuals.

Step 2 The director reviews the draft storyboard checking the feasibility of the suggested visual and graphic displays and noting options and alternatives where necessary.

Step 3 The author rewrites the storyboard incorporating the ideas and changes indicated by the subject matter expert and the director. Since revising the storyboard may involve updating the entire script or major re-writes, the production schedule should allow the instructional developer/author sufficient time.

Step 4 A script editor reviews the revised storyboard.

Step 5 The subject matter expert reviews the revised storyboard.

Step 6 The director spot checks the revised storyboard.

Items checked should include:

- Graphics clearly described
- Source materials identified
- Audio instructions clear
- Existing video segments specified by SMPTE number

Production sheets are the Bible for subsequent tasks in the development of an interactive videodisc. Therefore, the time required for a final review by the author expert, director, and editor will be worth the effort. Many times ideas, needs, or alternatives are not noticed until the storyboard has been prepared in near final form. Also, reviewing the document from different perspectives often produces a better product. As a result, what may seem somewhat repetitious in fact accomplishes a different purpose with each review.

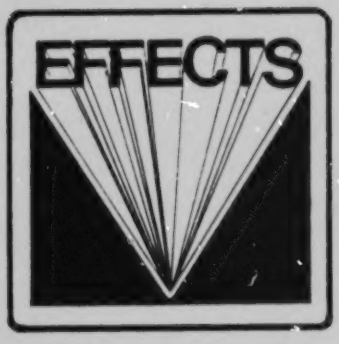
Conduct a Formative Tryout

You can learn a great deal about the effectiveness of a lesson by conducting tryouts with one or two persons. In some instances it may be possible to use the production sheets themselves for this tryout. Where more complex interactions are required, the student may use the video character generator which permits computer control as well as integration of external video components. In some cases, a simulation which combines videodisc with computer-generated overlays can be validated by using the computer program to generate the overlays and photos or a live TV camera to feed in the external video image. Computer-controlled videotape can be expensive and unwieldy, but it is a good option for some types of programs like complex simulations.

In conducting the tryout it is important to note such things as consistency and pace. Following the limited tryout, production sheets can be rewritten.

For controversial or changing subject matter, it may pay to have an independent expert review the materials.

Plan Special Effects and Animation



Special effects/animations can enhance the impact and effectiveness of the instruction, and plans for such effects must be made early. At this point in the development process you must become familiar with the possibilities and feasibility of these special video enhancements.

The possibilities for special effects are practically limitless. Here are some representative types of effects.

- Wipes or dissolves at scene boundaries, such as increasing circle, square, top-to-bottom or left-to-right transitions.

- Compression/expansions or push/pulls using digital video effects. A full-screen picture can be dissolved into an image filling just a fraction of the screen, or vice versa. A new scene can be "pulled" in, "pushing" the old one off the opposite side of the screen (rather than simply coming over the top of the old one, as a wipe). More than one of these special effects can occur simultaneously, either with equipment having multi-channel capability or by recording one portion and then re-recording with a second portion. Newer digital video special effects include sequentially filling the total screen with multiple same- or different-sized screens, either a row at a time or randomly, then transitioning to a full screen.

- Cartoon-effect features, modifying normal video, car be supplied by newer post-production equipment. This supplies a slightly abstracted multi-section two-dimension coloring. Straight-line effects can be given to facial features. Another random-box effect carves up the scene into small-to-larger sizes which become less and less distinguishable as the original image.

- Another special effect is the three-dimensional rotating cube, using two channels. One face of the revolving cube can have any of the above effects in it while a second face simultaneously rotates into view. The third face coming into view has the original image while the fourth face has the second image.

Other special effects can be provided, such as:

- Pattern rotations between scenes
- Flip/flops
- Repositioning video
- Comet tails
- Highlights
- Split wipe patterns
- Quad splits
- Windows

A good video studio can demonstrate many of these, or you may want to get a demonstration videotape from a digital video effects equipment producer.

- Existing Videotape List
- Video Shot Sheets
- Special Effects Requirements List
- Art Requirements List
- Prop List
- Photo Shot Sheet
- Script

The person with responsibility for this step is the director of production, with assistance from the author/writer and expert needed.

The preparation of these production lists is indispensable to the control and quality of art and graphics, photos, slides, and motion and still video. These lists not only specify the type of material needed, but also help the director monitor the progress of each task by providing information on the status of the production process.

Let's walk through the preparation of each of the lists and note the important points included in each.

Existing Videotape List

The existing videotape list indicates those videotapes or portions of videotapes that have been transferred from films or were already available as videotape footage. It is preferable to transfer film to videotape and thus avoid the cue up, start and stop time required for film editing. Many video production houses do not have motion film facilities. Also, working in one medium is usually more cost-effective.

Video Shot Sheets

The video shot sheets specify the new videotape segments that will be produced, including instructions about the interface with the following shot. Figure 3-1 is a sample video shot sheet.

The video technician or director should review the shot sheets to determine the most cost-effective way to tape the footage.

Generally it is best to prepare shot sheets in two passes. The first pass is organized by subject matter. Then all scenes that require the same lighting and props are grouped. The second pass is the shooting guide. The reason for the second pass is that lighting and other set-ups for shooting are very time consuming. Imagine arranging and shooting a very complex

MODULE 3

PRE-PRODUCTION

This module describes the tasks needed to complete pre-production development of an interactive videodisc.

This module will help you do the following:

(1) Given a completed storyboard, prepare media production lists.

(2) Given the contents and sequences of a lesson, lay out the videodisc geography.

(3) Present a typical timeline for interactive videodisc production.

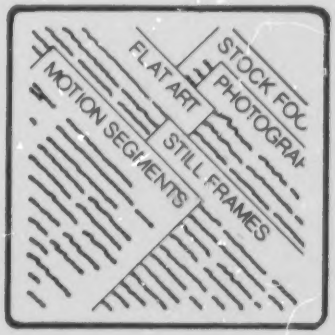
Major Steps in Pre-Production

The major tasks in this stage require members of the production team to:

- Prepare the production lists/script.
- Obtain available masters.
- Select the talent.
- Lay out the disc geography.
- Plan the production.

Prepare the Production Lists/Script

This is a major task in interactive videodisc production. At this point in the development process, the production sheets serve two important functions: (a) they provide a guide for the instructional material which specifies lesson flow, branching, interactions, and answer processing, and (b) they contain the data from which source production lists will be organized or created.



Using the completed production sheets which specify audio, video, and graphic requirements, you may need to prepare several production lists. Which ones you use, if any, depends on the size and complexity of your project. These may include:

group scene, then moving to another shot, only to find later that everyone must be called back and everything set up again because the author specified a similar scene later in the storyboard.

Often, it is easier to shoot stills on 35mm film rather than video. These film stills have the advantage that they can be shot with a video camera later to select any portion of the picture and place it anywhere in the video frame. This is a boon during video character generator work, since positioning of the text may require the photo to be placed on one side of the frame for a split. With video, the subject must be originally shot to fill just the portion of the screen desired, or digital special effects must be used in the studio. These effects are not generally available during video character generator work.

If motion will be used, video stills can be picked off easily. If only a few stills are needed it is easier to shoot everything with video than to switch between video and film.

Special Effects Requirements List

This list assures that all of the requirements for special effects planned for in the lesson development have been clearly considered. This list can aid video personnel in preparing a special effects tape. If effects are limited, the production sheets themselves may suffice as guides.

Art Requirements List

Each piece of art work should be given an Art Number, cross-referenced to the production sheet. When a piece of artwork is completed, it should be signed off.

Prop List

The prop list is for noting the actual items that will be required for live camera shots and set-ups.

Script

Preparation of the script from production sheets is primarily a secretarial function. The draft script should include production sheet numbers. A second pass through the script should add directions to the narrator, especially for pronunciation.

NOTE: Before these various production lists are distributed to production personnel, it is important to attach copies of each production sheet indicated on the production list. In that way, the original production sheets remain intact, but each member of the production team has access to all of the necessary specifications. It is disastrous to pull information from the production sheets before they are reviewed and complete. A change on one sheet can affect several production lists.

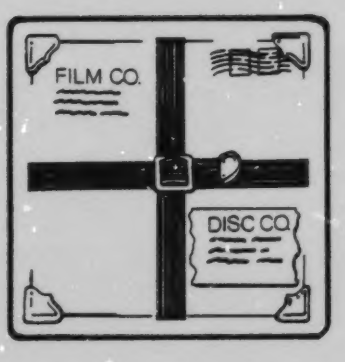
Figure 3- 1

Figure 3- 1 Page ___ of ___
VIDEO SHOT SHEET

Shot Number	Prod. Sheet Number	Subject	Instructions	Shot Date
23	76	Instrument Panel	Motion of Starting sequence.. Master switch on Instrument switch on Push starter button	6/28/81
24	93-107	STE/ICE	Stills of NG 81	6/28/81

Obtain Available Masters

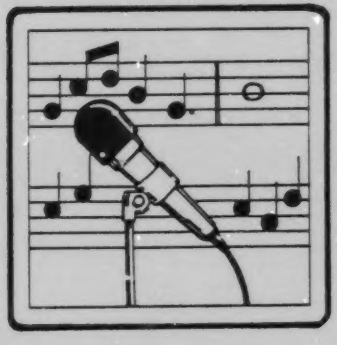
Whenever possible, masters should be obtained for subsequent production work because the final outcome will usually be better quality. When it is not possible to obtain original material, however, you may be able to get release prints of film, "clean" dubs of videotape and best quality copies of other media.



Where film or existing videotape footage is extensive or complex, it may be preferable to obtain dubs (usually 3/4") of that material at this point in the development process. Inclusion of the SMPTE time code will enable exact specification of segments to be used. Also, the character generator operator can use the videotape to align video overlap frames. Graphics personnel can refer to the videotape to verify details readily, match colors, ascertain perspective, etc. Finally, video personnel can review these dubs for style and setting prior to shooting new footage.

Select the Talent and Music

Professional talent is generally worth the investment. A professional narrator is someone who not only has the technical skills and voice qualities, but a person who knows how to accept directions.



The tone of voice has a tremendous effect on the final product, so a director must not be afraid to direct. Even good voice quality cannot cover sloppy narration. Typically, the most frequent correction is to caution narrators against artifical "emphasis" and "variety". Content must always retain first priority over delivery. In fact, a director should not hesitate to use a non-professional expert when the content is so technical or complex that a non-expert would seem trite or forced.

A good test for a potential narrator is to have the person read the script to determine how long it takes him/her to understand it. During this reading, the director should do some directing to assess how well the narrator takes direction.

If music is required for introductions, background, etc., you may benefit from these suggestions:

- For most audio requirements, 1/4" tape is adequate. You should determine what playback facilities will be available, however, including the format you will use in the production facilities:

  Four track
  Half track
  Full track
  3.75/7.5/15 ips

Music selection should attempt to fit the mood and the content of the material. Introductory music should catch and hold the attention; background music must blend with the presentation and not distract. Attend to this when watching TV or movies, to hear some examples.

When mixing the music, remember that it can be done in the audio studio if it goes under the narration. Where matching of video with audio is important, it may necessitate waiting for studio video editing capabilities. Ensure that the audio levels are balanced--the narration must be predominant in the presentation.

Music royalties are paid by the "needle drop" or on contract.

Lay Out the Disc Geography

A preliminary disc layout plan determines the program directions needed to locate given segments of the lesson. On multiple disc projects this is especially important because of branching logic and specifications required. The search time needed to locate a specific segment influences where it should appear on the disc. The minimum worst case search time is for material half way through the videodisc; hence, segments that are referenced frequently may be best placed at that position. When still frames (single frames) are referenced, however, it is much faster to simply replicate the frames close to where they may be called on the disc. The cost of inserting still frames is minimal--only one second of real disc time is required for thirty non-audio still frames--while branching time is greatly minimized.

If a still frame glossary were needed for each of three separate lessons, for example, search time would be minimized by inserting the glossary following each lesson. Or, if a glossary were needed for each of three separate units of instruction (on three sides of videodisc), it should be inserted on all three sides.

Introductions would typically be placed near the inside of the videodisc, since the player begins playing from the inside to the outside edge. On the other hand, where placement is not critical, small motion segments can be inserted wherever tape time allows--following or between lessons, on the flip side of a two-sided disc project, etc. Menu pages, unless they are computer generated, need to be located as close as possible to the place from which they are referenced to minimize branching time.

Plan The Production

The pre-production planning conference is the occasion to provide an overview of the final product for production personnel, showing how all the pieces fit together and how the tasks depend upon each other.

It is worthwhile to explain the importance of timeliness and consequences of failing to meet deadlines. All production personnel could attend this meeting as well as the author/writer, director, expert, and programmer.

Assignments for actual production tasks can be made at this meeting, distributing the media production guides to the appropriate persons.

NOTE: At about this point in the production process, a date should be discussed with the videodisc mastering facility. Three weeks before sending in the tape, an order should be placed to assure a place in the queue. (See Module 5 for a description of the forms and procedures for preparing the master videotape for videodisc mastering.)

A major objective of a planning conference is to anticipate problems and work out their solution ahead of time.

Time Estimates

An important responsibility of the producer is accurate estimation of time for production tasks.

Several tasks determine the minimum timelines for the entire project. In the design and authoring stage, writing the storyboard is the activity that requires the most time and effort. In the production stage, the creation of still frames on the character generator is the task which will usually require the longest to complete. The amount of video studio work is highly dependent upon the complexity of the graphics and motion segments. We typically make 1500 edits in a 30-minute videodisc. This is because of the large number of still frames. A complex videodisc typically requires between 30 and 45 hours per side in the video studio. The bulk of this time is spent in

editing. During the post production stage, two tasks could require a considerable amount of time, with both dependent upon each other: Building the work tape(s) and editing source materials onto the master videotape. Because videodisc mastering is beyond the control of the producer, sufficient time must be allowed in planning to cover "worst case" situations. Currently, videodisc mastering takes from 6 to 12 weeks, although mastering facilities may advertise very short turnaround.

Following are two editing examples of interactive videodisc development projects. The first example is from a two-sided biology disc designed for college coursework. Table 3-1 indicates a breakdown of still and motion edits. Stills are divided into character generator pages and art or photography frames. Motion edits include both stock and new footage. As noted, while the total still frames represented only 3% of the total tape time, these still frames edits required 43% of the total editing time. Also, it is interesting that still edits using live camera studio set-up required 30% of the editing time, or more than twice as much time as other still edits.

Table 3-1 Editing Breakdown

	Still Edits		Motion Edits
	Character Generator	Live Camera	
Number of Edits	1987	877	58
Percent of Edits	68%	30%	2%
Hours Editing	8¼	19¼	37
Percent Editing Time	13%	30%	57%
Time on Videotape	1:20	:30	51:10
Percent of Time on Videotape	2%	1%	97%

The next example comes from a three-sided videodisc for training Army missile mechanics in troubleshooting procedures. A total of over 3000 edits required approximately 104 hours and editing time. Table 3-2 gives a breakdown by type of edits and time per edit. This gives a fairly accurate estimate for doing still frame edits, with those requiring set-up taking about twelve times as long as those from a character generator.

It may be less expensive to do live camera taping separately, using only a camera and a still frame store or one videotape recorder in the studio. The tape is recorded with many frames for each intended still picture. Later, just one of these frames is edited onto the master tape. An alternative is to use slides which, like video character generator pages, can be easily sequenced and rapidly transferred to tape during post production. For high volumes with little or no editing, 35 mm

roll film and an animation stand can be used. The film is then transferred to tape at 30 frames per second. Any art that requires a switcher or digital special effects will be far more expensive than art that can be shot directly.

Table 3-2 Still Edit-Times

	Total Edits	Edit Time	Time/Edit
Character Generator	750	3 hrs. 13 min.	15 sec.
Live Camera	1514	72 hrs.	2 min. 50 sec.

Still/Motion Tradeoff

In preparing programming for videodisc input, careful consideration of the disc capacity should be made.

The tradeoff between motion scenes and still frames is illustrated in Table 3-3. For ease of comparison, motion scenes have been expressed in three-minute sequences. Still frames are assumed to occupy one videodisc frame each and to provide 10 seconds of user time. An estimate can be made based on your production details and an understanding of the effects the nature of your material will have on capacity.

The figures given are based upon the 30 minute or 54,000 frame maximum capacity. One-side capacity will vary with functions, features, design changes, and mastering house.

Table 3-3

Still/Motion Tradeoff

Motion Time Used (min.)	Still Frames Available 54,000-(min. x 1800)	Total user time in hours, at 10 seconds per still
0	54,000	150.0
3	46,800	135.5
6	43,200	120.1
9	37,800	105.1
12	32,400	90.2
15	27,000	75.3
18	21,600	60.3
21	16,200	45.3
24	10,800	30.4
27	5,400	15.4 *
30	0	.5 *

* Most productions fall in this range.

Preproduction Guides and Checklists

Appendix D presents guides and checklists that may be of help in planning your production.

MODULE 4

PRODUCTION

This module shows how the outcomes from the pre-production stage are used to produce the actual video, graphic, and audio materials required for the master videotape. Specifically, this module:

- describes how to fill out production sheets to guide the creation of audio, video, and graphic materials
- explains the use of the video character generator for producing video text pages
- notes special considerations for using art, music, narration, photographs and videotape in interactive videodiscs
- reviews disc layout suggestions

This module will help prepare you to:

(1) Use the character generator to produce pages of videotext from given sample storyboard production sheets.

(2) Describe typical kinds of program functions required in an interactive videodisc.

Produce Video Text Frames, Animations

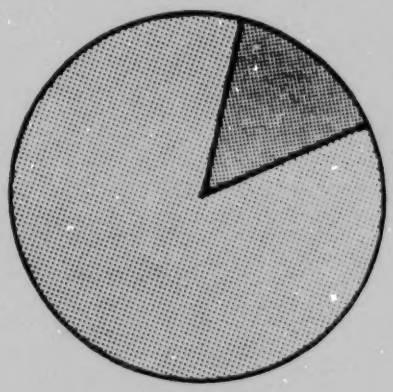
The bulk of text on the videodisc will come from a video character generator (CG). We use a Fernseh (Telemation) Compositor I. A number of other high quality machines such as Chyron and Vidifont are readily available. It is a great advantage to have the same equipment in both the production area and the TV studio, since the magnetic disks can then be transferred back and forth without moving the equipment. Using the storyboard as a guide, the video character generator operator enters the text and produces each frame according to standard formats. The formats specify spacing on the page, rules for centering, type font to be used for each application, background color, color of characters, and edges.

Graphics and animation can be accomplished in a number of ways. We typically use standard board art for graphics, but have also used the Compositor graphics digitizer for some of the graphics/ animations. An example is a highly detailed animated bus on the ARI disc. Another scene called for the Big Dipper to move through the night sky so soldiers could locate the North star. This was accomplished by painting the stars on a large wheel, and rotating it in front of the camera. Other motion segments were achieved by two frame animation, in which two similar frames are quickly alternated. This technique was used for a segment in which a soldier appears to dig a foxhole as his shovel flies back and forth. A third type of animation can be achieved by recording a series of still frames on the videodisc. Under computer control, the still frames can be played out quickly to achieve a sense of motion. This technique was used on the ARI disc for a multicolored cross which grew in all four directions. An advantage of this approach is that the speed of motion can be varied under computer control.

The key to success in the use of the character generator is a competent operator. This person must be experienced in the character generator's system's capabilities. Here is a suggested approach to learning about the system available to you:

Step 1 Review the constraints of your video character generator system. Most CG systems have a 12 lines per page limitation with a maximum of 28-32 characters per line, depending on the type and font size.

Character generator characters cannot overlay each other. However, diagrams like the pie graph below can be built in two colors using the pruduction switcher.



Different type fonts and methods of highlighting (shadow, outline, etc.,) change the length and width of rows and columns.

SHADOW

Step 2 Experiment with color combinations, font styles, backgrounds, and formats. Before making final decisions on type style, color, backgrounds, and edging, take the time to actually look at how these combinations appear on the screen.

NOTE: Be careful to see that the monitor is registering colors cccurately. A color bar generator will ensure proper adjustment. Use the delivery system (not studio) monitor.

You will need to decide which backgrounds to use, how headings will appear, whether graphics and animations will be used (graphics generated), and which font styles and sizes are preferred. Generally 18 scan lines is the minimum size.

NOTE: Characters will always be proportionate to the size of the screen; therefore, size must be visualized in relation to the rest of the screen.

Step 3 Review the capabilities of your CG system. Depending on the configuration of the equipment, you may be able to compose graphics (using the graphics pad), do background "swapping," do animation, and perhaps several other functions. Knowing the unique characteristics of your system will help determine the "personality" of the lesson materials. Remember, however, that your system must be compatible with that of the studio where you do post-production work.

Step 4 Review the editing capabilities of the system. Once a page is composed, changing font, color, background or format is relatively easy. Fine tuning and adjustments are also possible in the studio, although major changes should be made before post production begins, if possible.

Since the pages of text are stored digitally on a magnetic medium, authors can quickly assess the visual impact as well as the content, and recommend changes, before post-production begins. These changes can be made on the spot.

Step 5 Determine production rates. Text pages typically require from 3-5 minutes per page for an experienced operator, while graphics composed on the bit pad may take several hours, depending on their complexity. Here's a complex graphic, for example:

Here's one even more involved:

Detroit

Step 6 Establish regular communications with CG operation. Either the producer or the director should determine a review schedule with the operator. Such reviews may be hourly to begin with and then be conducted on a daily basis, or periodically, thereafter. These reviews serve two purposes: (a) they catch undesirable formats early, and (b) they obtain an indication of CG productivity.

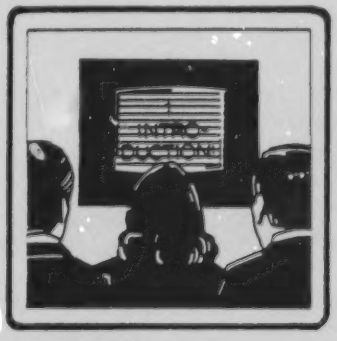
As for animations created by the video character generator, these are generally of two types in the Production Stage:

(1) All elements of the sequence are made in art work, transferred to the video character generator through a graphics tablet, and then animated by programming.

(2) A basic piece of art is drawn, then entered into the video character generator by video camera. The first program, once specified, then causes the several elements or "views" of the sequence to be built and stored as part of a special character generator font. The second program then animates these "views".

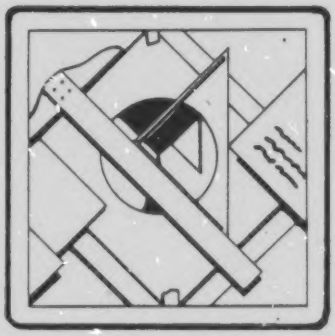
Review and Approve Text Frames

During the generation of text pages on the video character generator, a number of reviews must occur. These reviews help ensure the accuracy of the content, appropriate style and level, grammar and spelling, as well as specified formats.



Produce Art, Photographs, Print

This series of tasks involves standard production techniques for creating art and shooting motion sequences. However, here are some suggestions which may facilitate the production of the interactive videodisc.



NOTE: If artwork is required:

- Where artwork will appear as still frames on the IVD, it may be accompanied by video character generated text. When this is the case, space should be allowed for this textual information. The Art Requirements List is the form used to specify and control this production task. (See Module 3 for a description of this list.)

- During review and sign-off of the art work, the author checks for compliance with instructional specifications, the expert confirms the technical accuracy, and the director evaluates the visual quality of the materials and of any text that is to be transferred by camera.

NOTE: If photographs/slides are required for the videodisc, here are some things to consider:

- As with art work, allowance should be made for text (either video character or computer generated) to overlay the photograph for still-frame sequences. This may mean leaving ample borders for repositioning the point of focus on the subject.

- Use video (TV) aspect ratio (ratio of width to height), and stay within the Safe Title Area.

- Care should be taken to ensure that set-ups do not produce high-contrast pictures when shown on a television screen.

- Strive for the highest resolution possible on pictures, since each generation will decrease the quality.

During this stage, the final printed videodisc label, jacket and user guide should be prepared if required.

Review and Approve Art, Photographs, Print

The prime consideration during this activity is to verify that the art and photographs match the information specified on the production sheets. In addition to technical quality, the director should also check the visuals for proper screen proportions and text space. The print designs should also be reviewed.

Shoot Location Video

A competent video team is a must for interactive videodisc development. Because still frames may be chosen from motion sequences, it is imperative to have high quality and properly framed video material.

The shot sheets prepared in the beginning of this stage are the key to obtaining the material specified in the production sheets. Each location on set-up should have its own shot sheet listing. For instances where additional set-ups are required, keep a list of all scenes shot at that location and add a new production sheet.

Choosing a Production Medium

Videodiscs are always mastered from videotape. However, production can use film, slides, videotape, or a still frame store.

Motion picture film is useful where:

- The results will be used only for motion sequenes.
- The location equipment must be light and portable.
- You are shooting large numbers of stills where no editing or cropping will be needed (e.g., from a copy stand). This will be transferred at 30 frames per second (fps) to video.

- You are shooting motion that must have solid still frames that do not flicker between fields. This will be shot at 30 fps and transferred directly to video, or at 24 fps and transferred to video using the 3:2 pull down and picture codes.

Slides are useful when shooting a large number of still frames (e.g., for equipment simulations) that must be edited or cropped.

One inch type C videotape is generally preferred for motion sequences. If only a few stills will be shot and if a video crew is already shooting motion sequences, videotape or a still frame store (for studio shots) is a good choice for stills as well.

If shooting new videotape footage is required, here are some cautions to observe.

When mixing new footage with stock footage, certain problems are inherent, including:

Color balance--hues and color temperature, may vary from film to tape.

Dated material--the period or style of equipment, dress or grooming should not detract from storyline.

Audio--quality differences in recording, style of presentation, voice differences, and music must be evaluated for suitability and match.

When shooting new video, allow time for dissolves, transitions and pauses. Match the shooting with the script, allowing for pans, zooms, tilts, etc. while pacing the narration.

Be certain the video personnel follow the shot sheet directions explicitly so all required material is taped. Repeats cost money.

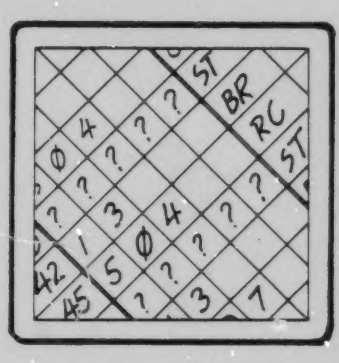
If still frames will have accompanying audio, running video will be of better quality; however, tape and equipment costs must be weighed against costs of 35 mm slides, for example.

Slate video sequences for easier location later.

Maintain a comprehensive list of all scenes in sequence.

Write the Computer Program

This task involves programming the kinds of interactions the lesson design calls for, including branching, answer-processing, data updates, quiz and test routines, etc. Also student response mechanisms need to be written. The functional spec is the guide.



Following are several suggestions for making this task more effective.

Step 1 Hold an orientation meeting with programmers to review the program requirements. This meeting should be an exercise in communicating the specific types of interactions so clearly that they will not be misunderstood.

Step 2 Hold periodic review sessions (daily if necessary) to revise and refine the program functions. In the process of writing the routines, questions will be raised concerning a variety of issues. Close coordination at the outset will save time.

Step 3 Review the routines to ensure that all interactions are covered. Some typical instructional routines include the following:

- lesson driver
- lesson maintenance
- simulation driver
- simulation maintenance
- logon/logoff
- registration
- report generator
- problem generator
- exam maintenance
- system intro
- user input routines

Shoot Studio Video, Record/Edit Audio

This task consists of shooting studio video sequences, recording audio narration, and mixing music.

There are several things that make this task more effective:

- Make sure you have all the props (books, manuals, objects, etc.).
- Ensure that sufficient personnel are available to move props, set up displays, position objects, etc.

Where narration is involved, there are certain procedures that may facilitate the IVD production process.

- When recording the narration of the script, be aware of the speed or rate of speaking. By increasing the rate of the presentation, more information can be packed on a side, but then there must be a capability to insert breaks under computer control for intervening material.
- By recording audio on both tracks of the videodisc, a compression of information may be accomplished. You should check the branching specs for the videodisc player you will use, since the search time varies according to the length of the audio on the first track.

If dual audio tracks are used with video, the video must be appropriate for both tracks since a motion sequence will be replayed with the second track. However, the video may be turned off and one track used for random-access audio or with computer-generated text and graphics.

- A second language may be recorded on the other track where only single track recording is required for the first language, thereby doubling the utility of the videodisc program.
- Generally, audio recording should be done after all graphics and video work is complete. In this way, any changes in the text or material can be reflected in the narration.

Guidelines for mixing audio are similar to those for music.

The director should check SME notes and correct the script for the narrator. In many cases it will not be possible to have a subject-matter expert with the narrator while the recording is done. In this case, a scratch tape is produced and reviewed by the SME, then sent to the narrator as a guide for the final production.

Review/Approve Video and Audio

A thorough review of all video and audio sequences should include formal checks by the director of production, the video production personnel, author and expert, if possible.

We have found it useful to review the completed video and audio by comparing them with the specifications of the production sheets. This not only provides a context for the visuals/audio, but also serves as a final check. The importance of an accurate and updated storyboard cannot be overemphasized. At least one revised copy should be available at all times.

MODULE 5

POST-PRODUCTION/PRE-MASTERING

This module presents the tasks involved in studio post-production, including off-line edits, master videotaping, computer programming, and data entry for interactive videodics. In addition, instructions for delivering the master videotape to the videodisc mastering facility are covered.

Specifically this module will prepare you to:

(1) Give the reason for building a work tape in the post-production stage.

(2) Describe the use of SMPTE time code in the off-line editing process.

(3) Given a SMPTE time code, calculate the videodisc frame number.

Major Steps in Post-Production/Pre-Mastering

The major tasks in this stage of the development process require post-production team members to:

- Conduct off-line edits
- Make an edit master tape
- Review and approve the master videotape
- Calculate frame numbers and enter the videodisc computer program
- Enter final frame numbers; test and debug the program
- Deliver the master tape to the videodisc mastering facility
- Review/approve the disc-coded master tape

And finally, it requires videodisc mastering personnel to:

- Make a disc-coded master tape

Postproduction Hardware

Postproduction is both critical and expensive, and you should therefore choose carefully the facility that you will use. Postproduction for interactive videodiscs, including still frame postproduction, can be accomplished at most modern, well equipped video postproduction studios if experienced personnel are available. The following major types of equipment are strongly recommended, although alternatives are possible. If you do not use

this type of equipment, you should work only with a studio that has already done videodisc still post-production. The recommended equipment can be found in the television studios of a few military bases and industrial corporations, as well as most medium-sized American cities.

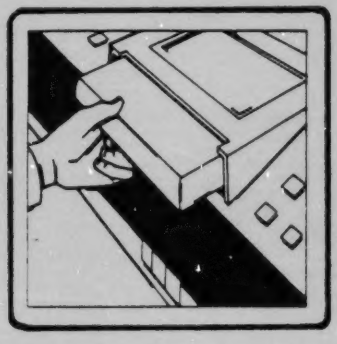
Major pieces of equipment are:

- 1" type C videotape recorders (minimum of 3)
- a computer video editor
- a broadcast quality character generator of the same type used in production. In many cases production and post-production can use the same character generator.
- an audio playback unit
- audio mixer panel
- broadcast quality video camera
- magnetic digital still frame store -- optional. This device can be used to dump large numbers of still frames to tape, or to allow examination of individual still frames if 2" quad videotape equipment must be used.

You should consider using specialty houses for transfer of large numbers of slides to videotape and for film to tape transfers where the user will examine individual still frames from the film. You should also consider using a specialty house for extensive video animations.

The above list of major types of equipment is intended only as a guide to locating an appropriate video postproduction studio. There are many more critical pieces of equipment than are presented here, but a studio that provides this equipment will almost certainly have the vector scopes and other ancillary equipment required.

Conduct Off-Line Edits



This is the first of the post-production tasks which organize all of the lesson segments into videotape format prior to studio videotape mastering.

Besides the convenience of having a single format, film transfer to videotape allows frame accurate off-line and studio editing. Frame numbers can be assigned to select any given segment.

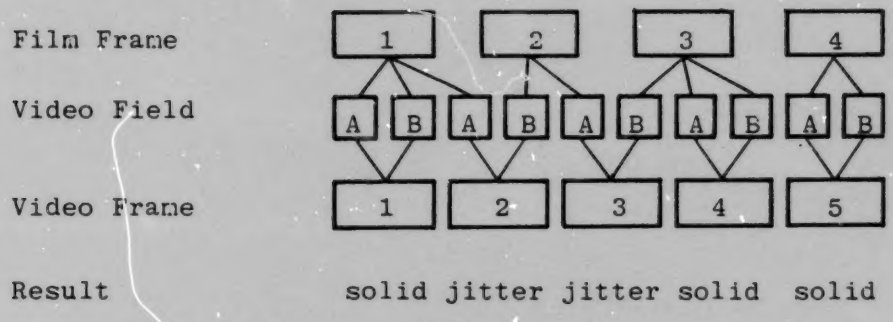


Figure 5-1. Relation between film and video frames using the 3:2 pulldown. Six of these sets result in the Standard 24 Film Frames and 30 video frames per second.

Transfer of Still Frames to Tape

Transferring material onto the master videotape can become quite critical if still frames are used. This is because both fields must be present for every frame, and both fields must come from the same frame.

When transferring from videotape to videotape, even computer editors can sometimes put in just one field, which can throw off the rest of the still pictures. It is also possible for an editing system to insert the edit before field one in some places and before field two in other places. For motion this is not critical. For stills it would be disastrous. Therefore, you must check that the editing system is consistently editing into one field or the other, and that it is always laying down two fields for each frame. Most computer editors and tape machines are programmed to begin the edit in field two, but this can usually be easily changed. You should especially attend to this if you are editing materials in different studios, where editing might be done in different fields.

When transferring film to videotape, an additional problem occurs. Film usually moves at 24 frames per second (fps). Video moves at 30 frames per second. The transfer equipment handles this using what is known as the 3-2 pulldown. This simply means that the first film frame is transferred to three video fields, while the second film frame is transferred to two video fields, the next film frame is transferred to three video fields, and so on. Figure 5-1 presents the relationship. So long as the film sequence on videotape is seen in motion, there is no problem. However, if the user desires to stop on one of these video frames using the videodisc STILL control, two of every five video frames will alternate between film frames, and thus will tend to jitter.

There are four approaches to transfer a film to videotape for videodisc use:

- If the film is a motion sequence, you can advise the users that the videodisc sequence is intended for motion, and that if they stop on a still frame they may see some jitter. Under manual control, the user can simply move ahead or back one frame to find one that is solid.

- Where the film contains both motion and still frames that are intended to be seen as stills on the videodisc, you can place a picture code on the videodisc to tell the videodisc player from which field it must refresh in order to get a solid picture. This requires you to use a "cue code inserter" during transfer from film to videotape. If you plan to use this option, you must contact the mastering facility to obtain a cue code inserter or verify that the mastering house you plan to use inserts the proper codes for that facility.

- For a small number of still frames you can record three film frames for each still picture, then transfer to video. Under

computer control, the programmer or data entry person can select the appropriate solid still frame and direct the program to seek out only that frame from the series.

- The fourth approach for film to tape transfer is to shoot the film at 30 frames per second. A few movie cameras are set up to do this, but 30 frames per second is seldom used in the film industry and therefore requires you to exercise great care, since frame counters may not work correctly. Film at 30 frames per second has some advantages: it transfers directly to video, and each resulting video image will be solid since both fields come from a single film frame which itself is solid. (There may be some blur on the film caused by subject motion but there will be no jitter.)

  If the entire film is stills, where motion speed is not a concern, film can be transferred at 30 fps.

  A word of caution about 30 frame film to tape transfers: every film frame in this situation will transfer to two adjacent video fields. Unless the transfer is made with special precautions, the transfer may begin in either field one or in field two. So long as the transfer is consistent and all the other materials on the videodisc are either stills beginning in the same field as the film to tape transfer or are motion, there will be no problem. However, if you have stills beginning in one field on one part of the videodisc and in another field on another part of the videodisc, you must either re-edit one section or send the tape to a mastering house that will make the adjustments for you. If you do neither, you will have one section that combines two adjacent still pictures as the fields alternate.

To summarize film to tape transfers, you should have little problem so long as you are transferring motion. If you are transferring stills from film to tape for videodisc, you should work with a group that has done it before and has the equipment and experience necessary to do it right.

Safe Title Area and Aspect Ratio

Film and video have different aspect ratios (ratio of width to height). In preparing film or graphics for a video production, you must design to video aspect ratio. A number of video and cartoon firms make such grid outlines. You should also be aware that all text and most graphics should fit within the safe title area. This is an area at the center of the television screen where it can be assumed that even a poorly adjusted television or monitor will contain the entire picture. Again, most video firms can provide a grid of safe title area for production personnel. Basically the safe title area is the center 80% of the screen.

Worktapes

A persuasive argument for using worktapes are the studio cost savings that can be realized. Assembling artwork, slides, photographs, character generator pages, camera and some special effects is much less expensive on the minimum equipment possible outside the post-production studio. This procedure allows extensive work prior to editing the master tape and can reduce final editing expense considerably. But costs a tape generation.

Review Equipment. Upon completion of the master videotape, a 3/4 inch off-line review copy is made. Since most standard 3/4 and 1/2 inch players use a helical scan system, it is possible to review individual still frames using the pause and frame advance features provided by some videotape players. Most modern players using this format permit a pause on an individual still frame. They also include a means of adjusting the picture slightly to remove the bar from the picture which occurs between frames. This adjustment is intended only to remove the bar, not to sequence from frame to frame. Therefore, it is possible, using the adjustment, to go forward but not backward. Thus, while it is possible to review the videotape so long as one knows the exact location for a segment, it is exceedingly tedious to branch around the videotape in the manner of an interactive videodisc. More expensive 1/2 and 3/4 inch editing equipment permits the tape to be searched in either direction at several speeds, including a frame at a time. This video cassette editing equipment, however, is usually based upon counting pulses rather than the SMPTE code which is an absolute address on the tape itself. Errors in pulse counters are cumulative, so can be substantial at the end of a long edit session. Thus we feel that video cassette editing equipment will be useful (though not required) for production reviews and off-line edits by the production staff. It will be of much less use to authors and instructors for tryouts because relatively long search times do not give a good feel for the finished product.

It should also be noted that the tryouts of the program on the videodisc can be most effectively conducted in smaller sections with one developer and one student, sometimes using just graphics and a script. Such an approach does provide a rough tryout of the materials, though it is time consuming and can be cumbersome.

It would be possible to use the one-inch videotape to conduct reviews and tryouts under computer control. This is an expensive option. For most applications, it is recommended that tryouts be conducted early in the development process, when changes are inexpensive. Thereafter, the authors should be able to review each of the graphics, text, and audio segments as they are produced. Once authors have signed off to the quality of these individual components, the final production into an integrated videodisc should be handled by production personnel. The cassette off-line review copy is valuable to

production personnel to create an edit decision list and determine whether edits were made in the proper place. The cassette off-line review copy is of less use, and is sometimes confusing, to the authors.

Once the disc is mastered, and during videodisc program entry, more changes can be made using the program and videodisc computer interface to add new text and graphics or to overly and correct existing videodisc frames.

Off-line Editing

This process involves assembling still sequences and motion segments and creating an Edit Decision List. Because edit points are determined and assembled on tape other than on-line on the finished master, time and convenience are the main advantages. The procedure depends on the system used. Total running time should be adjusted to fit the disc, with a little cushion.

Depending on the off-line editing system with which you are working, you may need to lay down SMPTE time code both visually and electronically. If editing on a computerized off-line system, electronic SMPTE time code on the audio track is required. Note that the pulse counters on some 3/4" videotape systems are not precise, though they are close enough for reviews.

- Single machine - this system requires one tape at a time editing, keeping track of what is needed, and noting the SMPTE time code for segments needed in the finished product. When using this system, the final tape may not look exactly the way it was envisioned, necessitating adjustments in the studio.

- Multi-machine - this system makes it possible to build an edited tape as you edit so that the worktape is closer to what the final product will look like. Again, with an off-line system, the time codes for each edit may not be precise.

  A significant limitation here is that special effects will not be possible without a switcher, a piece of equipment usually not available on off-line systems.

  Two systems used are:

  Electronic editor - this system has the advantage of showing how each segment fits together; it is also much less expensive to select edit points here than during more expensive studio time.

Computerized editor - the final outcome of this system is a paper tape or floppy disc which contains the edit decision list, a list compatible with the final mastering facility in the studio. This leads to significant time savings and multiplies the effectiveness of studio editing. Special effects will still have to be done in the studio, as also post-produced animation, and time must be allocated for that activity.

Edit Decision List

An edit decision list is included for use where off-line editing is required. The edit decision list allows the director to pull specified segments from different source videotapes in order to produce an integrated final product in the TV studio.

This list expands in relation to the size of the lesson or unit you are developing. This is a valuable tool for cost-effective off-line editing. A well-done edit decision list will simplify the work of editing source materials onto the master videotape.

Let's walk through a sample list. Figure 5-2 shows an Edit Decision List. The "Events" column (1) is the number of the edit in the order they proceed. The next column (2) is the number of the source videotape reel that will be needed for the edit. In the third column (3) you indicate whether audio and/or video editing is required. Such "Special Effects" as circle dissolve, rotating cube, random box, wipe, are in the next column (4). These effects may be further explained in the "Notes" column (7). The "In Time" and "Out Time" Columns (5 and 6) are for indicating the exact SMPTE time code information--hours, minutes, seconds, frames on the source reel--for each edit.

Figure 5-2

page__of__

EDIT DECISION LIST

Title_____ Project No._____

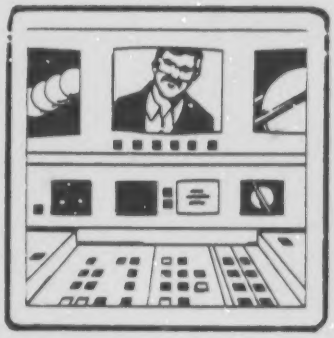
Producer/Director_____ Asst. Director_____

Editing Technician_____

Editing Schedule_____
(date)

1	2	3	4	5				6				7
Event No.	Reel No.	Edit A/V	Special Effects	In Time Hrs	Min	Sec	Frm	Out Time Hrs	Min	Sec	Frm	Notes

Make Edit Master Tape



Preparing a Master Tape involves considerable expenditures in terms of equipment and personnel. Because things typically take longer than presumed, preparing a master videotape can evolve into an unexpected financial drain. Careful time code selections, however, can reduce the risk of going over budget.

After the master videotape has been initialized with continuous SMPTE time code (a process which must be done in real time), you are ready to edit source materials following the guidelines on the production sheets and edit decision lists.

In many cases, this largely single-frame editing will not follow a chronological order, but will be performed to optimize specific studio operations. For example, all of the graphics which require a studio camera may be shot and laid in at the appropriate places (SMPTE codes) on the master tape. The videotape containing motion footage from other sources can also be laid in at the appropriate locations. Mixing of some audio, such as narration over already existing music, can be done using the computer video editing equipment. An audio booth should be used for more extensive mixing requirements. The following steps are a guide to editing:

Step 1 Determine final videodisc layout. Review the preliminary plan for laying out the videodisc. Changes on the edit decision list involving motion segments may mean the total time has increased or decreased. Also, the addition of still frame sequences may suggest these frames be included in several places on the disc.

Step 2 Inventory materials. Make a checklist for all worktapes, props, production sheet binders, edit decision lists, etc., needed in the studio beginning with the on-line editing.

Step 3 Lay down audio track. In some instances, it may be possible to lay down the entire audio track at once. This would be better, as then video can be matched to the audio -- an easier editing job than the reverse. In most lesson formats, the audio will be edited onto the master videotape in chunks interspersed with still frame edits.

Where fewer than 10 edits are required between motion segments, these can usually be sandwiched with no additional time requirements. For more than this number of stills, it is probably necessary to edit them and then lay down the next audio segment.

NOTE: To save time, leave 10 or 20 extra frames following motion segments for adding single frames later. If frames are not used, programming can branch around them.

Step 4 Shoot live camera work. By ensuring that props are created, personnel in place and edits listed, studio costs can be controlled for this production task.

NOTE: However, if a worktape had been built of this material this step would be skipped entirely.

Step 5 Edit still frames. After learning the capabilities of your editing system, there are several things to watch for during the creation of "freeze" or still frame editing -- editing that requires cuts from one frame to the next since it is not possible to dissolve from single to single.

(1) Check for full frames. Each frame must have two fields. The waveform monitor will indicate whether two fields have been recorded.

(2) Watch color framing. Ensure that the video technician checks for correct color framing pulses (or indicator lights),

NOTE: Watch for consistency from one frame to the next.

- Average Picture Level (APL) should be fairly consistant from frame to frame with good video balance.

- Check positioning -- the placement of props, and positioning of photographs or still video frames so that objects match from one to the next.

- Color/contrast may distract if it varies too dramatically from one frame to another.

- Check symmetry -- the balance between objects and text and proportion of visual representations among themselves.

Step 6 Edit motion segments. Standard editing procedures apply for this portion of the task, including the recommendation to "be prepared." Studio "on-line" editing costs money, but a great deal can be accomplished by having sheets, props, tapes and edit decision lists checked and available for all personnel.

(1) Document edits by updating the production sheets with SMPTE time codes and changes.

(2) Monitor color shift by watching the scope on editing equipment when going between two frames of the same color.

(3) Monitor the creation of special effects. As with the video character generator, you need to become acquainted with the capabilities of the video switcher and digital video effects equipment. The switcher will typically handle such things as patterns, boxes, wipes and highlights while digital effects include such capabilities as repositioning, shrinking, flip-flop, comet trailing, rotations, and movement of video information.

(4) A hard copy or disc log of the editing sequence specifies the type of each edit. This can be useful for estimating edit times (See Module 3, time estimates for editing).

NOTE: Certain alternatives and tradeoffs may be considered for highlighting, for example:

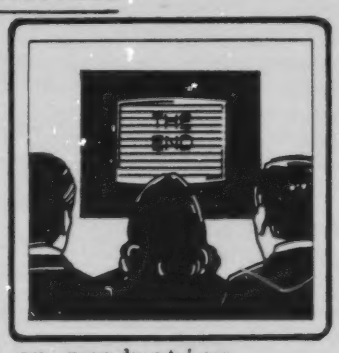
- Zooms show perspective, location and serve as "establishment" shots for providing the "big picture."

- Wipes can be done in a variety of ways. The main caution is to restrain the tendency to be too "creative", to the point of being gimmicky, thus distracting from the instruction itself.

- Dissolves and wipes require two sources (camera, tape, character generator, etc.). They are useful when changing from visuals where distinctions are minimal, as in radar equipment that looks similar. Dissolves are preferred over cuts where it is important for the student to recognize these differences.

NOTE: Depending on the technical complexity of the lesson context, it is usually advisable to have a subject matter expert in the studio during editing of critical material.

Review/Approve Master Tape, Print Materials



The director and author conduct an off-line review of the master videotape using the dub of the tape. You will need equipment capable of single frame advance. In most cases this will be a 3/4" dub. During this final review, use the storyboard production sheets as the master guide.

- Ensure that all frames specified on production sheets appear on the master videotape.

- Ascertain that each still frame has both fields.

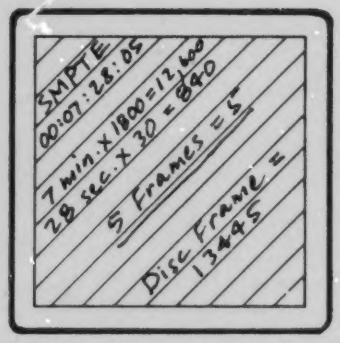
- Watch for consistency in audio and video quality.

- Check the total length of the lesson material - DVA recommends 27 minutes, SONY and 3M allow 30 minutes.

Approval of the master videotape indicates all the factors listed above have been checked by the director and author. Changes after this point should be made only if errors in subject matter are found. Even then, if changes occur in the content, updates may be made via computer overlay messages if available. This approach extends the "life" of a videodisc throughout several generations of changes with only minimal input.

Calculate Frame Numbers, Enter Videodisc Computer Program

After calculating videodisc frame numbers, this task involves the specification of branching, answer processing and program notes on every motion segment and still frame in the lesson or lesson segment.



It is very helpful if an authoring system for data entry will be available for actually accomplishing this task. If it is, this stage requires only that videodisc data be entered.

There are two major advantages to using templates: (a) they allow alternate programming to be created using all or portions of the same material in different sequences; this would be especially useful where users require similar training material, but perhaps with different emphasis; (b) they provide an interim step between global programming specifications and the creation of a finalized program.

Videodisc Frame Numbers

Even prior to receiving a cassette or check disc you can obtain videodisc frame numbers for puposes of program data entry. The following formula will calculate videodisc frame numbers:

M(1800) + S(30) + F = C

M is the number of minutes, S is the number of seconds, and F is the number of frames in the SMPTE time code. The formula converts minutes and seconds to frames. There are 30 frames per second, and 1800 frames per minute (30 x 60 sec/min). For example, if the SMPTE time code for a frame were 00:17:08:22 (17 minutes, 8 seconds and 22 frames) you would obtain a calculated videodisc frame number as follows:

```
  17 x 1800 = 30600
+  8 x   30 =   240
+        22 =    22
              -----
              30862
```

Some videodisc manufacturers can specify a given frame number for a given SMPTE number. Even if frame no. 1 of the videodisc will not correspond to SMPTE 00:00:00:01 of the tape, there will be a 1:1 correspondence. Thus if SMPTE 00:00:01 is frame 1297, SMPTE 00:01:00 will be frame 1326 (30 + the offset 1296). An external computer program can automatically add the required base frame number (in this case + 1296) to the frame numbers in the program. By letting the computer add the appropriate offset when it becomes known, the videodisc programmers can work while the disc is in mastering and before actual frame numbers are available. When the offset number is added, the program will search to the appropriate frame on the actual videodisc.

An alternative is to obtain from the mastering facility a review tape containing the frame numbers. The tape can be returned to you within a few weeks after you deliver your master tape. The important element is to keep your team productive during the 6 to 12 weeks that the disc is in mastering and you are paying their salaries.

Standard Frames

In the process of authoring the storyboard, generating video text and building computer generated frames for the videodisc, certain functions will become standardized. Whenever these can be identified, considerable time can be saved by replicating the particular frame in question wherever it is needed. Some of the frames that fit this description include the following:

- Log-on information
- First menu
- Last menu
- Test instructions
- Performance update
- HELP page
- Back-up message
- Caution message

Each project, of course, will generate its own list of conventions and standard message/feedback frames.

Automated Dated Entry

Automated computer programming represents a cost-effective approach for interactive video-disc data entry. Depending on the system you are using, the specific procedures will vary, but essentially this activity consists of creating computer code to support the following major functions:

- Control of Videodisc frame displays
- Computer-generated frames
- Answer processing routines
- Performance data update

The template approach is one means to accomplish this. Another approach is to create a library of subroutines in a general purpose authoring system. We have used several authoring systems and have developed special purpose videodisc authoring systems for this purpose. A well designed authoring system is valuable because it gives authors direct control over the final product and saves programming resources. Its other advantages is that it gives authors a track to run on and minimize "nifty ideas" that can turn into a programmer's nightmare.

Deliver Master Tape and Instructions

Before you can send the master videotape for videodisc mastering, some detailed information must be provided for the manufacturer.

Let's work through some sample forms just to clarify the process.

Step 1 Obtain the forms required by your mastering facility. An example is "Description of Material Provided for Mastering," Figure 5-3. This is the form to waive responsibility for material on the discs that may cause legal proceedings to be initiated. Forms should be obtained before production begins.

Step 2 Fill out a sample form. Using the project you are contemplating, fill in the appropriate information called for on the form. Because of the complexity of interactive videodiscs, it is a good idea to spend some time on the phone with the mastering facility before sending the videotape.

- Where a description of material is called for, indicate the type of media. In this case it will probably be just the 1 inch helical master videotape.
- Below "Special Instructions" the information called for may include such items as the start/end SMPTE time codes.
- Signature of person authorized to bind the company (customer) is required at the bottom of this form.

Step 3 Obtain the "Production Order" form. An example is presented in Figure 5-4. This form calls for information required for mastering the videodisc. Other mastering facilities may ask for different and/or additional information. Following is a brief description of what is required for the numbers 1-11 on the form.

(1) For the example used in these materials, you will probably have just the 1 inch helical master videotape.

(2) List total time of disc input.

Figure 5-3

DESCRIPTION OF MATERIAL PROVIDED FOR MASTERING

WARRANTY OF OWNERSHIP AND INDEMNITY

Customer Name and Address _____

_____

_____

_____

Customer Order No. _____ DVA Marketing Rep. _____

Date of Shipment to DVA _____

Customer is providing the following material to DiscoVision Associates for copying and replication.

Title of Material (if any) _____

Media containing the material: Separate forms must be used for each different media (indicate number of ft., time, and number of pieces).

☐ AUDIO _____ ☐ 2 INCH IVC _____

☐ 35 MM FILM _____ ☐ 2 INCH QUAD _____

☐ 16MM FILM _____ ☐ 1 INCH HELICAL _____

☐ 3/4 INCH U-MATIC _____ ☐ 16/35 MM FILM STRIPS _____

☐ SLIDES _____ ☐ OTHER _____

Special Instructions: _____

_____

_____

_____

For Side, ☐ A/ ☐ B. Insert at Track/Frame # _____ Thru _____

Disposition: ☐ Hold at DVA until _____

☐ Return Via Carrier To: (If other than address above) _____

_____

_____

Customer authorizes copying of the materials for the pre-production services and production of videodisc replicas by DiscoVision Associates. Customer represents and warrants that the material, including the likeness of all parties appearing in the materials, may be copied and replicated by DiscoVision Associates without violating any proprietary, copyright, trademark or other rights of any person or organization. Customer further warrants that all applicable payments for rights including residual, performance, or guild payments, and the like, have been or will be paid by the customer and customer agrees that such payments and any necessary record keeping relating to such payments are the responsibility of the customer. Customer agrees to defend, save harmless and indemnify DiscoVision Associates from and against any liability, loss, cost, damage, payment, or claim, resulting from or arising out of DiscoVision's copying of the materials or embodying the contents of such materials onto videodiscs.

Authorized Signature _____ Title _____ Date _____

Figure 5-4

DISCOVISION ASSOCIATES

CONTROL # _____

CUSTOMER P.O. # _____

PRODUCTION ORDER DATA WORKSHEET

CUSTOMER _____

SALES REP. _____ PHONE _____

1. TYPE OF MEDIA INPUT: CIRCLE ALL THAT APPLY AND NUMBER OF PIECES.

   A. 2 INCH QUAD _____ E. 3/4 INCH UMATIC _____
   B. 35 MM FILM _____ F. 16/35 MM FILM STRIPS _____
   C. 16 MM FILM _____ G. SLIDES _____
   D. 1 INCH HELICAL _____ H. OTHER _____

   TOTAL QUANTITY OF INPUTS _____

2. ESTIMATED RUN TIME OF INPUT: MINUTES _____ FT. _____ EST. SIDES _____
   (NOT MORE THAN 27 MINUTES PER SIDE)

3. OTHER SERVICES - CIRCLE ALL THAT APPLY

   A. EDITING B. AUDIO INPUT - 1 TRACK 2 TRACK C. AUDIO OUTPUT - 1 TRACK 2 TRACK
   D. ADD FRAME NUMBERS E. PROGRAM DUMPS _____ F. OTHER _____

4. CUSTOMER VERIFICATION REQUIREMENTS: NUMBER OF COPIES _____

   A. CHECK DISC B. CASSETTE C. LOW VOLUME REPLICATION
   D. CUSTOMER REVIEW AT DVA E. OTHER _____

5. REQUESTED SHIP DATE(S) _____

6. QUANTITY EACH SIDE ORDERED _____ _____ _____ _____ DISCS ORDERED _____

7. LABEL REQUIREMENTS:

   A. STANDARD DVA B. CUSTOMER DESIGN - DATE DUE AT DVA _____

8. DISC SLEEVE: A. DVA STANDARD B. CUSTOMER SPECIFICATIONS
   DATE DUE AT DVA _____

9. ALBUM COVER:

   A. DVA STANDARD B. CUSTOMER SPEC. DATE TO DVA _____

10. PACKAGING:

    A. DVA STANDARD B. CUSTOMER SPECIFICATIONS

11. SHIPPING METHOD: (FOB DVA PLANT)

    A. SURFACE B. EXPEDITE - AIR
    C. CUSTOMER CARRIER PREFERENCE _____

    _____

3/12/80

(3) Depending on the type of disc and programming requirements, you may need two track audio; you should always specify frame numbers.

(4) You may request a cassette with videodisc frame numbers within just 5 days of the mastering process; this would greatly facilitate program data entry requirements. Also, a check disc may be requested; although this usually requires several weeks to receive.

(5) These dates may have to be negotiated; depending on your hard deadlines, you may want to give yourself 30 days flexibility here, although DVA will rush replications for a fee.

(6) Sides are specified A, B, C, etc.

(7) You may specify custom labels. Standard DVA labels look like the one in Figure 5-5.

Figure 5-5

Standard DVA Label

(8) The disc sleeve may also be custom ordered. The standard sleeve is white.

(9) The cover can be custom designed as well.

(10) This item refers to whether discs are housed in boxes, album covers, etc.

(11) Depending on your deadlines, you may need to request Federal Express or some other overnight service.

Mastering Facility Makes Disc-Coded Master Tape

This is a videotape process in which your master is transferred to another tape and codes are added for frame numbers. By obtaining a copy of this tape with visual frame and field numbers printed in the picture, you can learn the absolute videodisc frame numbers prior to mastering. Obtaining a copy of the new tape takes time, and is optional. It does, however, give the programmer time to enter final frame numbers and debug the program prior to receiving the videodisc.

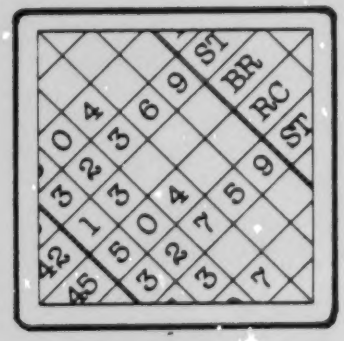
Review/Approve Disc-Coded Tape

If a disc-coded tape has been obtained, it should be reviewed at this time. Look for:

- Overall layout.
- Both audio channels if specified.
- Both fields within each frame number for stills.

Enter Final Frame Numbers; Check Program

No matter how carefully the software is programmed, the program will require significant testing/debugging. The following are possible steps in debugging the program with the finished videodisc master.



Step 1 Compute the offset number. Once you have a review cassette or check disc containing the actual videodisc frame numbers, you can calculate an offset number for each side of the disc.

If, for example, the actual beginning videodisc frame number were 1297 and the calculated frame number were one (1), you would simply add 1296 (the difference between 1 and 1297) to all frame numbers on that side of the disc.

If the actual beginning videodisc frame number is one, the difference between the calculated number and one is the offset.

Calculated	1
Actual	1297
Offset	1296

Step 2 Check the logical flow to make sure that the program results match up with the logical specifications.

Step 3 Check the computer-generated messages and menus. All of the choices indicated in menus, multiple choice questions, etc. should branch to the proper place, as indicated by the course map developed in the authoring stage.

Of course for a player-controlled videodisc, each frame number will need to be calculated and entered sequentially in the player's program. This is a time consuming task and must be planned for in advance. Many ohter types of debuggin are possible, depending upon the subject matter, the types of audio, video, visual input, and the nature of the interactions.

MODULE 6

MASTERING

This module presents the major tasks involved in the final stage of developing an interactive videodisc. A case study of our experiences with three different mastering facilities is presented. Procedures for debugging and refining the computer program are reviewed. Guidelines for implementating and evaluating the interactive delivery system conclude the module.

This module will help prepare you to (1) describe the final steps in the mastering stage of interactive videodisc development and (2) list three areas to review on the check disc.

Major Steps In Mastering

The major activities during this final stage require team members to

- Review the check disc (optional)
- Obtain the completed videodiscs
- Integrate the program with the videodisc
- Implement the Program

Interactive videodisc mastering is not a science. As experience accumulates, standard procedures will be worked out. In the meantime, it is not unreasonable to plan on six to twelve weeks for initial mastering.

Case Study

Until 1979, the Philips mastering and replication facilities in Holland had been used. The Philips facilities are laboratory facilities and are not set up for fast, responsive commercial service. Turnaround time has been five to seven months, and quality has not been the best. With such a long turnaround time, it was not feasible to attempt a second mastering at Philips. For this project, the services of three videodisc mastering studios (Philips, Sony, and Disco Vision) were compared. Videotapes were sent to each studio on the same day. The Sony and DiscoVision discs were received within a few days of each other, approximately seven weeks later. Philips reported that since they did not have considerable prior notice, their mastering would require 8 months. The first disc back was from Sony in Japan. The disc had two problems, and some discussion was necessary to clarify what had happened. These problems proved to be minor, and the second Sony mastering cleared up the problems completely.

In finalizing arrangements with DiscoVision prior to sending them the disc, the assumption that their disc held 29 minutes and 30 seconds of video (as does Philips and Sony) was found to be incorrect. Due to the injection molding replication process (plastic injected into the center of the disc mold and forced out the edges), DiscoVision Associates has had difficulty replicating discs so that the video programs hold up all the way to the outer edge. Videodiscs are recorded starting at the inside of the disc and ending at the outside. Because the quality of their replicates degenerates at the outside of the disc, DiscoVision Associates presently limits the total amount of time which they will record on one side to 27 minutes. This meant that it was necessary to divide videodisc materials, and to place part of them on a second side. The first side of the disc contains the common core of materials, including the TEC lessons. The second side contains the same common core of materials, but deletes one of the TEC lessons in order to leave room for the simulations and games at the end.

DiscoVision encountered some complexities in mastering the disc that caused them some extra effort. Also, the resulting copies had no audio on the second track because the engineers usually turn track 2 off to reduce noise if they hear no audio on track 2 at the beginning. This underscores the need for a standardized description of what is on the master tape, as a guide to the videodisc mastering studio. DiscoVision Associates issued such a guide in the second quarter of 1980, and there is now a standard form to describe the videotape as it is sent.

Both Sony and DiscoVision Associates were very accommodating and have gone out of their way to produce a high quality product. Both companies assigned special teams to re-master the disc. In both cases, re-mastering took approximately three weeks.

The second DiscoVision disc was excellent. Its only shortcoming was that the program was divided into two sides. The second Sony disc was also excellent, and contained the entire program on one side of the disc. However, its frame numbers were initially unreadable by the interface software. Investigation revealed that Sony turns off a check bit in the code which Philips and DiscoVision Associates (DVA) leaves on. This bit was formerly used as a chapter stop and is not specified currently. This bit was critical in the interface software. By ignoring this bit the software could read the Sony frame numbers.

As of 1982 Sony and 3M have mastering facilities, with Pioneer taking on DVA's mastering and other firms considering providing services. The number of facilities is thus limited, but likely to expand.

Disc Layout

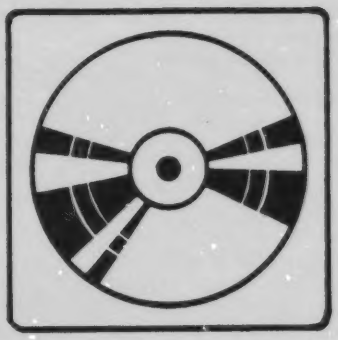
Table 6-1 presents an example of how start/stop points were specified for a three-sided disc project. Notice how each side requires "bars and tone" and "black" at beginning and end. Also, each side is listed separately and SMPTE identified for start and end of each segment, and any black frames in the video segment.

Table 6-1

DARPA Project Master Videotape Layout

	start	end
Side 1 (Tape 1 - part 1)		
bars & tone	00:01:00:00	00:01:59:29
black	00:02:00:00	00:02:59:23
1st program video	00:03:59:24	00:28:05:08
	one black frame at 27:50:04	
black	00:28:05:09	00:29:05:27
video	00:29:05:28	00:29:23:05
black	00:29:23:06	00:29:59:29
Side 2 (Tape 1 - part 2)		
bars & tone	00:30:00:00	00:30:59:29
black	00:31:00:00	00:31:59:29
video	00:32:00:00	00:57:10:27
black	00:57:10:28	remainder of tape
Side 3 (Tape 2)		
bars & tone	00:01:00:00	00:01:59:29
black	00:02:00:00	00:02:59:29
video	00:03:00:00	00:29:26:02
	single black fields appear at	
	03:27:29A 08:22:07A	calculated the same as all edits for SMPTE #s
black	00:29:26:03	remainder of tape

Review the Check Disc (Optional)

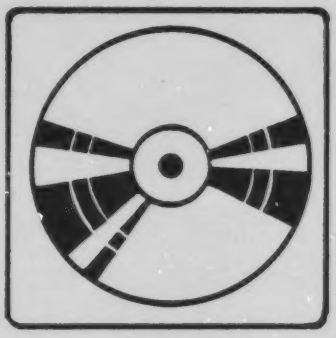


Prior to final videodisc mastering you may obtain a check disc or its equivalent in order to conduct reviews and begin program integration. Although each videodisc mastering facility has different procedures, there is usually some way to verify that video and audio components appear on the disc as specified. You should watch for the following problems:

- Do the correct frames appear?
- Do some frames jitter or alternate between two images?
- Are all the necessary frames on the disc?
- Are audio levels consistent?

During the review of the check disc the reviewers may find some content errors, typographical errors, misspellings, etc. Finding such problems is truly a serious reflection on the quality of prior review steps, for example reviewing video pages on a video character generator before premastering took place. Nevertheless, it is so easy and convenient to review the content of the videodisc page by page that these errors may sometimes be noticed only on the check disc. If so, it may require another trip to the video studio for corrrections.

Receive the Completed Videodiscs



Because of the involved process of videodisc mastering, copies of the completed videodisc may take 6 to 12 weeks for delivery. How you are able to utilize this time depends upon one critical factor--whether the computer program is on the videodisc itself.

If the delivery system incorporates external computer control, the entire six to 12 weeks may be spent in testing and debugging

the computer program. If the program is on the videodisc itself, however, the mastering group should send back a check disc for testing. Once the programmer has completely validated the code which will run the disc, the final program is submitted to the mastering facility to be included in the videodisc master.

It is also helpful to contact the mastering facility regularly to avoid possible delays and to make sure that the project stays on schedule.

Debug and Refine Program with the Videodisc

Once the programmer receives the videodisc, integration can begin. The objective at this point in the process is to ensure that program functions are behaving the way they were designed.

During this integration the following branching functions should be checked:

- Check that branching is to correct frames
- Check function keys. Make sure each key does what it was designed to do. The "one key, one function" rule should be followed as much as possible. These may include directional keys such as BACK, NEXT, REPEAT, ZOOM IN, ZOOM OUT, JUMP, STOP, and the like, as well as specialized keys such as HELP, MENU, NAME, TACTICS, VOCABULARY, REPLACE, SET, or TEST.
- Check routines. These may include performance update for students following quizzes and tests, lesson status, or menu branching. You need to ensure that branching works between as well as within units.
- Check system reports. This information includes student performance updates on quizzes and tests as well as status reports concerning lessons completed and course assignments.

The formal integration and testing at this point in the development process is a direct reflection of the functional specifications designed during the authoring stage. Test cases should be prepared to check branching, scoring, reports, and special features such as those previously described. If the program responds reasonably to all input,

whether anticipated or not (hostile), you can be reasonably secure that it will work as designed. Specifically,

- the program branches to the place intended
- each function works as designed
- the scoring of quizzes and exams is correct

This final testing of the program corresponds with Block III.5 (Validate Instruction) of the IPISD model.

Implement Videodisc Program

The next step in the development of an interactive videodisc is to implement the program according to the management plan determined during the project planning stage. This step involves conducting actual instruction and collecting data on all of the instructional components for the purpose of evaluating and revising the system. These activities constitute Phase IV (IMPLEMENT) of the IPISD model.

Assuring the Quality of the System

Phase V of the IPISD model (CONTROL) involves ongoing evaluation and revision of the instructional design. An internal evaluation (Block V.1) of learner performance in the course can pinpoint lesson segments that are deficient or irrelevant and suggest ways of improving the presentations. An external evaluation (Block V.2) assessing task performance on the job can yield valuable feedback. The data from both the internal and external evaluations may be used as quality control input to revise the external computer program where one is used.

Appendix A

SOME LESSONS LEARNED

This section presents some of the lessons learned in making an interactive videodisc training program. Most of the suggestions are presented in other parts of this document but are summarized here. The observations relate to both management and to the design and production of videodiscs.

Management

- One person must have the vision and ability to link a user who has the need for an interactive videodisc with a proponent who has the dollars. Neither the user nor the proponent may have considered or even know about interactive videodisc. The person who makes this link is likely to be the producer referred to elsewhere in this workshop. The producer must have the ability to explain the need, to garner the resources, and to get strong commitments.

- A good program must have both a strong proponent and a strong user. If either the proponent or user is uncommitted, the program is likely to suffer for lack of resources or to be shuffled from one person to another.

- Reassignment of military personnel is frequent. Therefore, in military projects it is critical to prepare a memorandum of understanding up front so that the needed resources are committed to the project.

- In addition to obtaining subject matter expertise, it is important to obtain reviews by those who will use the material for training but were not involved in the project. This will tend to correct the use of non-standard procedures in the training, as well as to provide a more balanced review of the material to be presented.

- Primary users should be involved in the development project. The person who is the primary contact among the users should be someone who will still be there when the program is implemented.

- Programming support should be obtained early. Whereas subject matter experts, writers, graphics artists, and video production personnel are currently available in the services, programming support is much more difficult to obtain. A software User

Requirements document should be prepared to describe the hardware, software, and basic approach. The programmer should then help develop detailed functional specifications for the software.

- Once the program has been developed, it should be "tried out" first with instructors. Their observations and suggestions should then be used to guide revisions. Beware of differences between the short cuts of an individual instructor and the procedures that were used for making the interactive videodisc program.

Design and Production.

- An interactive videodisc training program should be considered when equipment that is the subject of instruction (e.g., a fighter plane) is scarce or expensive. It provides more realism than paper and pencil exercises, and is far less expensive than 3D replica simulators.

- Before beginning work on an interactive videodisc production, you should attend a workshop and visit other groups who are developing similar programs. The Workshop Guide you are now using will be a great benefit, but it is important to gain some hands-on experience to appreciate the complexity of the process.

- During the design phase, visualize exactly what a student is to do and what he or she will see during the course of the program. It is helpful to do a walk-through from the time the student first comes up to the interactive videodisc system until that student leaves again. Each of the major modules and functions in the interactive videodisc program should be described in the walk-through. These should be included in the User Requirements document.

- Pick a short, simple program to start. Other programs have attractive or exotic features such as special video effects or a simulation that models a complex system. In almost every case these features have a high associated cost. Keep it simple. One simple approach is to use a linear simulation. In such a simulation there is only one path through the still frames. If the student makes a mistake, the program forces a correct response before it goes on to the next videodisc frame. This approach is easy to produce and program, yet produces high interest.

- If you use a 2D equipment simulation, be sure to teach component locations and spatial orientation of equipment either as part of the simulation or off-line in a mockup, 3D simulator, or actual equipment.

- During the design phase give careful attention to streamlining authoring forms and procedures. This step can save hundreds of

hours later! You should also consider using different forms and procedures for different segments of the videodisc. For example, motion sequences may be authored using a standard storyboard format. Linear equipment simulations, on the other hand, can be authored using graphic forms that portray the equipment so that the author need only circle the part of the equipment to be shown on each videodisc frame.

- Investigate authoring systems and weigh their costs and limitations against the large software effort required for most types of interactive video.

- Consider designing the program or parts of it for small groups as well as individual use.

- Design user interactions to be self prompting, consistent (e.g., terminate all keyboard entries with <return>), and forgiving (tolerant of errors). A forgiving system is designed to
  - handle unexpected inputs gracefully
  - check for responses that are out of bounds before processing the potentially disastrous results
  - allow the user to exit a section that was entered by mistake without waiting several minutes or being forced to make a long series of responses.

- Use specially labelled function keys or preset touchpanel locations to make interactions easier. Examples of such keys are NEXT, EXIT, and HELP.

- Include a glossary or similar reference aid.

- Use existing materials when possible. This is especially the case for motion sequences since film and videotape libraries often contain excellent materials. The interactive videodisc allows these to be mixed even when color balance and characters are different.

- In most cases, emphasize demonstrations, simulations, games, and graphics in interactive video. Text should usually be minimized.

- During production for videodisc simulations, shoot only those stills that are needed. If it is efficient to do so, shoot them in the sequence of the procedure in which they will be used. If this is not feasible because of lighting or other problems that make it difficult to change from one piece of equipment to another, shoot the equipment in logical groups so that a given procedure or component will be easy to find on the videotape for off-line editing.

- Use computer-generated text and graphics to display computer-generated problems and to make corrections after the disc is mastered.

- A single video frame consists of two overlapping fields. Editing of single frames must consistently begin in one field, and each frame must contain both fields. Even with a computer editor, single frame edits should be checked.

- Postproduction will be easier if helical videotape recorders, a studio quality multi-font character generator, and a computer editor are available.

Appendix B

TOUCH PANEL GUIDELINES

For applications that do not involve the entry of large amounts of text, a touch panel is much easier to use than a keyboard. Moreover, for certain simulations where the user is interacting with equipment or other graphic representations, it is usually easier to touch a section on the graphic or picture than it is to use a keypad. A touch panel, moreover, provides a keypad with an infinite number of keys since any number of legends or graphics can be placed on the screen, and the user can choose among them.

One disadvantage of touch panels is that they require space on the screen to be dedicated to the prompts or menu items to be selected. Thus, touch panels are less well suited to applications where the user can select among many functions at any time. In this case, a functional keypad is usually a better choice. Moreover, for the entry of large amounts of text and data, as for example when entering students' names or for simulated forms filling exercises, a keyboard is usually the best input device.

Touch panel input over a long period of time requires the user to sit within an arm's length of the TV screen, and to constantly reach up to the screen to touch it. Sitting this close to a screen that in some cases is jittery, can produce eye strain. Moreover, it can be uncomfortable to be always reaching up to the screen.

Touch panel input should be considered when:

- the user will frequently designate sections from a graphic or video picture.
- the screen will be used in a public place where input devices like keypads and keyboards attached by a cord might be damaged.
- the user can invoke only a small number of functions at any time.
- the user can take breaks or will not be required to sit close to the screen for extended periods of time.

Compromises are possible: If the user needs a touch panel to select among graphic elements, but also must have the ability to select among many functions at any time, a combined keypad and touch panel may be the best choice. This type of input system is used for computer-aided design applications. If only one input device can be used, one location at the bottom of the screen can be dedicated to a menu. The

user indicates graphic elements until a specific menu function is required. The user then touches MENU and is presented with the functional choices.

There are several technologies used for touch panel input. One group of systems paints the surface in front of the screen with a series of infrared or ultrasonic beams, placed at right angles to each other to form a grid. Interruption of these beams by touching the screen with a finger establishes the coordinates of the touch. Because the screen is curved and the light or sound beams travel in straight lines, the sensors must be located out as far as the highest point of the screen. At the edges, this means that the user must sometimes move a finger away from the screen in order to avoid interrupting the beams. This makes it difficult to tap the screen rapidly if this type of response is required. Moreover, it is sometimes frustrating to have to make such large motions when making choices. Another problem with the beam approach is that the user must touch the screen relatively straight on. Since the beams are sometimes an inch above the surface of the screen, the finger may interrupt a beam well below the point actually touched on the screen. This can give false readings.

The efficiency of beam approaches depends on the flatness of the tube being used. If the tube is flat, the disadvantages described above do not exist. Moreover, the beam approach can be relatively low cost, although infrared offers lower resolution than most of the other approaches. For most training and education applications, very high resolution touch input is not a requirement. Therefore, for training applications the beam approach may offer the lowest cost touch panel alternative.

The other basic approach to touch panel input is to add a sensor to the screen. One type of sensor consists of a glass plate and a plastic sheet overlaying it, separated by spacers. The user touches the plastic sheet, which then makes contact with the glass. The sensor circuitry detects the change in resistance or capacitance of the sensor caused by this short circuit and reports the location of the touch.

The screen sensor approach described above overcomes the parallax problems of using straight beams on a curved screen, since the sensor can be curved to match the screen. The screen sensor approach typically is more expensive than the beam approach, but also offers higher resolution.

Touch panels are just beginning to come into wide use. Therefore, you must be wary of claims and promises of different vendors. The best approach is to talk with users of different systems and gain by their experience.

Appendix C

GUIDELINES FOR USE OF VOICE INPUT FOR INTERACTIVE VIDEODISC TRAINING SYSTEMS

Background on Voice Input

General Applications

Voice input is a means to increase total system productivity. The user is a critical part of the system, and the primary advantage of voice input is in providing more rapid and efficient communication between a human and the computer software.

Voice input is used in a number of industrial and military applications. It is not widely used in training. The following section presents a number of general applications, followed by specific applications for training and job aiding.

Voice applications fall into three distinct categories:

(1) Speech Recognition and Understanding
(2) Voice Authentication
(3) Word Spotting

Speech Recognition and Understanding is the mode most often thought of when voice input is mentioned. Note that most current applications involve only recognition of an utterance. For example, the system might recognize the digits "2", "3", and the command word "ENTER". This is accomplished by matching the voice input against a stored pattern that was previously recorded. An "understanding," system on the other hand, is able to use syntax (language rules), semantics (meaning), and context in order to paraphrase, translate, or carry out the intent of the voice input.

Voice Authentication is a means to verify that a speaker is who he or she purports to be. Voice authentication systems are used to eliminate or supplement ID cards and other means of gaining access to secure facilities or information, since cards and access codes can be stolen.

Word Spotting is a specialized type of speech recognition in which specific words or phrases are scanned for a verbal record. For example, this is used to look for key phrases in monitored conversations in national security applications.

The applications of speech understanding (as opposed to simple recognition) are so extensive and far reaching that a true revolution

in man/machine communication will take place when speech understanding becomes widely available. However, it is not presently commercially available, nor is it likely to be available within the next five years. Therefore, this report is focused on speech recognition.

Speech Recognition is used in the following types of applications:

(1) Where hands and eyes are busy or limited. Examples are:
- Quality control inspections
- Entering data for numerical control machine operations
- Voice controlled job aiding devices
- Cockpit controls
- Logging freight to its appropriate destination
- Receiving, shipping, and inventory
- Air traffic control
- Computer-aided design and manufacturing
- Voice actuated wheelchairs
- Cartography (map making)

(2) Translating natural language (e.g., English) commands into complex software protocols, especially where little training is possible. Examples are:
- Command, communications, control input
- Data collection at the factory floor

(3) Applications where front panel space is very limited. An example is an aircraft cockpit.

(4) For applications requiring freedom of movement, or where the user must be separated from the computer system and has access only by telephone or radio without a computer terminal. This allows remote access by a phone to computer data banks and for commercial transactions. Examples are airline reservations and bank-by-phone applications.

Other applications are of specific interest for training and job aiding. Examples of these are:

(5) Computer-assisted instruction (CAI) simulations for training tasks normally conducted using voice. Examples are:
- Pilot/air traffic controller communications
- Calling in artillery fire

(6) Providing a natural interface for non-typists with a computer. An example is data entry by an observer during a field test.

(7) Job aiding where the computer acts as an information resource or consultant. An example is a system that calls up maintenance information in response to spoken commands or queries.

Speaker Dependency	Continuity of Input Speech			
	Isolated	Segmented	Connected	Continuous
Dependent	X	X	X	
Independent	X			

Note: An "X" indicates commercial availability in First Quarter 1982.

Table B-1. Types of voice input systems.

Comparison of Alternative Voice Input Technologies on the Market Today

During the course of the investigation of voice input, a variety of manufacturers were producing or introducing voice recognition systems. These manufacturers include:

- Verbex
- NEC
- Threshold
- Auricle
- TSC (Technology Service Corporation)
- Interstate
- Votan
- Heuristics
- Centigram
- Scott
- Voicetek
- Calma

Types of Voice Input

The spoken utterance that is recognized can be as short as a sound or brief word lasting only a fraction of a second, or it may be as long as a phrase or sentence lasting about three seconds. Thus the utterance need not always be a single word.

There are no commercially available systems today that handle unconstrained continuous speech such as we use in everyday conversation. Such a system would provide continuous recognition. What is available is a tradeoff between different approximations to this at a reduced cost. At the low end of the spectrum are isolated recognizers. These systems require the speaker to pause approximately one-tenth of a second between each utterance. Segmented voice recognition systems permit a much shorter pause (approximately 25 milliseconds), but a pause nonetheless. This type of system can be used with digits for rapid entry of numerical information. However, since pauses within words are typically as long 100 milliseconds, segmented speech systems must sometimes guess at word boundaries, and they can confuse one long word with two short words.

A connected speech system permits a limited number of utterances from a limited set to be spoken without pauses. For example, a connected system might recognize the digits 0 thru 9. These systems are clearly one step closer to continuous recognition, and will help us to gain some practical experience and anticipate some of the problems to be encountered with continuous recognition.

Speaker dependent systems must be trained for each speaker's voice. Thus they are dependent upon which speaker is using the system. Speaker independent systems work for most speakers without training, but are usually limited in vocabulary (e.g., to digits spoken by American males).

Table B-1 presents a brief description of the types of voice input currently available. Both the capability of the system to handle continuous speech and the speaker dependency of the system are considered.

Through hands-on comparisons, interviews with users, and study of a comparison study by George Doddington at Texas Instruments (TI) (Doddington, 1981), the first 10 systems have been roughly ranked from higher to lower recognition accuracy. Sufficient information was not available to rank the others. Because recognition accuracy is so dependent on speaker and vocabulary, and because new systems are introduced frequently, the ranks are only approximate.

Since the analysis, Heuristics and Centigram have gone out of the voice recognition business. The TSC system is a hybrid combining an Interstate system with a TSC-developed system that in essence counts syllables and is therefore speaker independent for items containing different numbers of syllables.

These manufacturers produce systems ranging in price from over $100,000 to less than $100. As might be expected, recognition accuracy and features tend to follow price. However, Doddington found little difference in recognition accuracy between the NEC system selling for $65,000 and the Threshold system selling for about $17,000. On the other hand, there was a larger difference between the Threshold system, and Interstate and Heuristics systems in the range of $2,500 to $5,000.

Based on actual hands-on tryouts, it is clear that the user should insist on a very high level of recognition accuracy. The reason is that low recognition accuracy severely limits the applications for which a system can be employed, and increases user frustration very rapidly. Today that accuracy costs approximately $9,000 (as exemplified by the OEM-oriented Threshold T580X). However, recent advances described below make it very likely that high quality voice recognition will dramatically decrease in price in the next decade.

Likely Advances

After using several voice input systems in a number of applications programs, it is obvious that voice input is attractive to many users. There is an element of naturalness and excitement about talking to a computer and having it respond. This is partly because voice input systems automatically handle the "computerese" required for some systems. Instead of an elaborate invocation of typed commands, the user simply speaks what is wanted.

This strong sense is shared by many users of voice input systems, and makes it likely that as applications using voice input become more cost effective, voice input will find a larger utilization.

Advances in voice recognition are proceeding on two fronts: The first is decreasing cost brought about by large scale integration in new

electronic chips. The second is work on speech understanding, continuous recognition, and speaker-independent recognition. Advances on the former are proceeding more rapidly than on the latter.

By the end of 1982, it is likely that inexpensive digital signal processing chip sets will be available. These are critical to progress in voice recognition. Their availability in chips will make it possible to produce inexpensive systems that incorporate the very sophisticated recognition algorithms now embodied in "top of the line" voice recognition systems. A system that costs $10,000 today may cost as little as several hundred dollars in 1992 if the market for voice input greatly expands as the price of chip sets falls. The price will come down in any event, but if the market is large, very large scale integration (VLSI) of many circuits will be justified and will further cut costs.

TRAINING APPLICATIONS OF VOICE INPUT

Guidelines for Identifying Situations Where Voice Input Would Be Useful

The most productive training applications today for voice input are probably those where job interactions are normally conducted by voice using a very constrained vocabulary. Examples are pilot and air traffic controller communications, or calling in artillery fire.

Voice input can be considered when an application falls into one of the areas listed earlier. There are today few applications where the current state of the art of speaker independent recognition will increase productivity. One example, however, is obtaining data base information where the user can simply speak a few commands and digits to retrieve the data. This might be used by NCO's to enter and retrieve student information without typing. Students could use the system to respond during hands-on simulations, exercises, and tests, where their hands were occupied and the vocabulary consisted of the digits and a few statements like "Yes," "No," and "Repeat."

Applications of speaker dependent recognition today are much greater because the vocabulary can be larger. However, each user must train the system on each utterance. If an application requires relatively untrained users to enter general data into a computer, such as recording job performance tests where many types of observations must be made, voice input is a candidate.

Voice input can be used to walk a student through a hands-on task using a job aid. The student calls by voice for the next action to be presented or for a repeat. The student can also verbally request help. Such a system connected to an interactive videodisc is being developed in the VIMAD (Voice Interactive Maintenance Aiding Device) project sponsored by DARPA.

When considering voice input for training, the following should be considered:

- The vocabulary must be small (preferably 100 utterances or less) for a speaker independent system, and about 20 utterances or less for a speaker dependent system.
- There must be some flexibility to replace, modify, or add to some of the utterances if they are highly confusing.
- If a speaker dependent system is used, students must have time to train the system (usually about 10 to 30 seconds for each utterance) and to retrain it when recognition errors are found.

Results of a Voice Recognition Formative Tryout

In order to investigate voice recognition for videodisc training systems, several systems were evaluated. One was selected and software utilities were developed for it. It was used to run a number of existing programs. The following case study is not a definitive guide or recommendation but rather an indication of the state of the art in 1981.

System Used. In order to investigate alternative approaches, structured interviews were conducted by telephone with engineers at each of the major manufacturers of voice input systems. In addition literature was obtained from each of these manufacturers.

The Verbex and NEC systems (at the high end of the spectrum) were eliminated because of their high cost. These two manufacturers produce systems with the highest recognition accuracy, but they were too expensive to consider for most training applications. Also eliminated from consideration were the very low accuracy systems that sell for a few hundred dollars. Hands-on tryouts included models by Threshold Technology, Heuristics, and Interstate. Based on the tryouts and demonstrations, the Threshold Technology system was selected because it was the only one that met our high criterion for recognition accuracy and for a reasonable cost, $9,000.

Threshold offers many variations on their basic system. One is a complete stand-alone system, while another requires a separate computer but is much less expensive and permits the user to control all of the relevant parameters through the user's interface program. The latter was chosen in order to investigate the full capabilities of the system. Threshold offers both isolated and isolated/connected systems. An isolated/connected system was chosen in order to determine the effect of connected discourse on training applications. Finally, Threshold offers a range of vocabulary sizes. A middle range of 100 utterances was used.

Software Development. Two utility programs were developed for voice input. The first, VOCUTIL, permits the user to enter prompts and output strings, train the system, test each utterance for recognition in either isolated or connected modes, and control each of the major parameters of the voice recognition system. In most cases, what the user says is what the voice output system sends on to the appliction program. For example, if the user says "one" the voice system sends "one". However, sometimes what is sent to the applications program is different from what is said. One example is saying, "go" and having the voice input system send a carriage return. Another example is saying "skip down" and having the voice input system send a control character that is interpreted by a word processing system as the command to move down a line. The "prompt" is what the user sees and says when training the system and when

using voice input. The "output string" is what the voice system sends to the application program.

The other utility, VOICEKEY, permits one computer to run both the voice input system and a standard application program. The voice input replaces keyboard input for existing programs. Using this utility, existing programs can immediately be put under voice control without modifications required. Developing user interface programs required several months of a senior programmer.

Applications Investigated. The investigation involved a broad range of applications for voice input as soon as the two utilities described above were completed. The following section describes each of these applications:

- Call For Fire Simulation. As part of this project a simulation for calling in artillery fire using an interactive videodisc program had been developed. Students who had to type in the commands became frustrated. A keypad for input was therefore developed where each of the major functions (e.g., ADD, DROP, FIRE FOR EFFECT) were labelled keys. This approach greatly facilitated student use, but did not correspond to the way the job is performed in the field since a radio/telephone is usually employed. Moreover, the labelled keys gave students cues that are not available in the field, and therefore changed the type of learning situation. The Call For Fire was put under voice control with excellent results. A student can immediately call in and adjust fire using the videodisc simulation, all under voice control.

- System Commands. Using the voice input utility described above, the user can control the computer at the monitor level. This means that the user can call up and run application programs, change directories, purge files, and perform other system activities. Conventions that are useful for typing do not necessarily fit voice input. For example, instead of typing "change directory," programmers simply type, "CD." Voice input permits the user to say what is meant, without resorting to abbreviations.

- Videodisc Authoring. One of the most important applications of voice input is for entering data. The videodisc authoring system developed for this same project permits the author or instructor to create the videodisc software by simply filling in forms. For example, one form is for motion sequences. The author specifies the starting and ending frames and the next form to be executed. Another form calls up a videodisc image and permits the author to overlay text over it. Voice input was used for both of these forms, again with good results.

  It should be noted that voice input for data is good for the

non-typist whose hands are occupied, and who does not want to learn a complex data entry procedure. The forms used for videodisc authoring are very simple, requiring a minimum of typing, and are usually filled in by someone whose hands and eyes are not otherwise occupied.

- Automatic Dictation. While voice input is far from being ready to do this today, a limited experiment was tried by creating a vocabulary, training the system for word processing commands, and then dictating, using the word processing system. It is unnatural to speak with pauses between each word as is required in the isolated and connected modes. Moreover, because a relatively large vocabulary is required, there were many confusions between words. One solution is to organize the vocabulary into subsets and to invoke a subset much as a typist uses the shift key. For example, there is confusion between the digit "two" and the word "to." While dictating the inside address for a letter, the speaker says, "digit set" to invoke the subset for digits. The speaker then gives the digits of the address and says, "open vocabulary" to invoke the subset containing most of the utterances to be used in the letter. For an individual's name or any other utterance not in the vocabulary that must be spelled, the speaker says, "letter set" to invoke the subset for the phonetic alphabet that outputs individual letters. Because letters are single syllables and are frequently acoustically similar, the phonetic alphabet ("alfa," "bravo," "Charlie," etc.) should be used.

Voice Recognition Errors and Methods Used to Fix Them

A number of fixes for recognition errors have already been described. Use of a high quality voice recognition system is important. Errors can then be fixed by creating a table showing the utterance that was spoken and the utterance that was mistakenly recognized for it. In some cases, re-recording the utterance is all that is required. In other cases, a different word should be used. If that is not possible, try appending another word to increase the difference from the utterance that was recognized in error. For example, if "move" and "moon" are confused, try changing the former to "move to."

Student Use Guidelines

Today, speaker dependent recognition is the most appropriate means for communicating with a training program by voice since it provides higher recognition accuracy. However, speaker dependency means that students will need to train the system on their voice and then fine-tune that training over the course of time.

For a student to train the system on 50 words at 10 repetitions per word, about 15 to 20 minutes will be required. This includes an initial orientation to the system and examples of how to speak and to

control the voice input system. The amount of time required to fine-tune the system depends greatly on the software. During the first several weeks of use, the student will find recognition errors. If the software permits the student to immediately stop, retrain the word, and then go on, the fine-tuning can proceed very quickly. Therefore, it is important that the voice input software be designed to work as an integral part of the training system.

It is best to use only high quality voice recognition systems. Manufacturers commonly advertise that their units provide 99+% accuracy. These figures are almost always inflated. Voice recognition systems each have their own idiosyncrasies, and highly trained users can make the most of a particular system. However, a student who is using the system for the first time may become extremely frustrated if general accuracy is not high. If a high quality system is elected, recognition will be high almost immediately after initial training and only a few words will need to be retrained. This assumes that the developer of the program has selected words that are maximally different to the voice input system. For example, it would be unacceptable to ask a voice recognition system of the type commercially available today to distinguish between the utterances, "to," "two," and "too." Only by understanding the context of the utterance can a system distinguish among these three.

Designing and Authoring to Make Best Use of Voice Input. Most of the better voice input systems allow structuring of the vocabulary into subsets. The training program can then invoke a subset of likely words for each spoken response. In this way, recognition errors are kept to a minimum. For example, suppose the student responses include LEFT, RIGHT, ADD, DROP, 50, 100, 200, or 400. The total vocabulary might consist of 100 items, but for a given response only the subset just described would be used.

It is critical to adjust the utterances (words) that the voice recognition system will recognize so that they are as acoustically different as possible. Different voice input systems have different characteristics and are therefore sensitive to different acoustic qualities. In some cases it is not possible to select the utterances to be used because they are prescribed by a standard procedure. In this case, subsets are a good choice. Another possibility is to train students to speak each of the acoustically similar utterances with a slightly different intonation or inflection. Students must then remember to always speak the utterances with that inflection.

The length of utterance is another important factor in selecting the vocabulary. Recognition will be easier and more accurate if utterances vary in length. For example, one utterance might be, "for." Another utterance might be "forewarn." Another utterance might be, "four hundred men." The number of syllables is a factor in the length of the utterance and in its recognition accuracy. If all utterances have the same number of syllables, recognition accuracy may

be low. However, if utterances use at least two syllables and vary between two and five syllables in length, voice recognition accuracy will be highest.

In segmented and connected recognition modes, where the voice input system is looking for several utterances together, there will likely be problems if one of the utterances is a multi-syllable word like "forewarn" that sounds like two or more other utterances in the vocabulary (e.g., "for" and "warn"). There is little advantage to segmented voice recognition over isolated recognition for most training applications. However, if a very small vocabulary like the digits and "enter" is being used for data entry, then the segmented and connected modes can be an advantage because they allow more rapid entry, while the small vocabulary decreases the probability of errors.

Core vs. Application-specific Vocabulary

In experimentation with a number of application programs for Call-For-Fire, automatic dictation, and videodisc authoring under voice control, a common core of utterances is used. This core includes the phonetic alphabet, digits, "go" and "return" for carriage return and carriage return line feed, "delete," "erase" (for five sequential deletes), and certain system commands. Altogether this common vocabulary comprises approximately 50 utterances.

Vocabulary Size. The system used provided 180 utterances, with up to 2 seconds per utterance. This was thought to be all that was required, but the vocabulary items quickly increased to fill the maximum space available. Vocabulary size seemed to be relatively unimportant for isolated word recognition. However, a large vocabulary size greatly increased the time to recognize utterances in the connected speech mode. As vocabulary size grows, the possibility that two or more utterances will be confused also grows. Therefore, large vocabularies should be structured into subsets as described above.

Effects of Reject Threshold and Pause Length. The system used (Threshold Technology T500X) permitted control of the reject threshold which is the determinant of how close a spoken utterance must come to a stored pattern for the utterance to be recognized. A high threshold requires an utterance to be spoken almost exactly as it was during training and therefore increases the probability of failure of recognition for anything. On the other hand, a low reject threshold makes it easier for the system to match an utterance against a stored template from the training session. The system becomes more tolerant of speaker variations caused by inflections, colds, and nervousness. However, a low reject threshold increases the probability for mismatches resulting in recognition errors. A middle setting (the factory default) usually provided the best recognition.

The pause length adjustment permits the designer to control how long a pause is required before the recognition system thinks that a second utterance has been spoken. The adjustment is critical because pauses

within words are often longer than pauses between words in normal conversation. The factory default setting in a middle range was the best to use.

Conclusions and Recommendations for Voice Input

Voice input is already increasing system productivity in a number of industrial applications. Voice input must be seen as part of an integrated system. If it is, careful system design using voice input can save both dollars and time. For training applications, voice input is useful where on-the-job communication is by voice. However, the fact that current systems require each student to train the system means that voice input should be considered only if students will be working with the system over a period of time.

For initial evaluation and tryouts of voice input, a stand-alone system should be used because it simply plugs in as a keyboard replacement. This approach is the least expensive if only one or two systems are being used. For larger applications, the software investment required to develop an efficient customized system can result in savings both in the initial hardware acquisition and in better day-to-day productivity.

VOICE INPUT

REFERENCES/BIBLIOGRAPHY

Armstrong, J. W. The Effects of Concurrent Motor Tasking on Performance of a Voice Recognition System. Monterey, CA: Naval Postgraduate School Thesis, 1980.

Armstrong, J. W. and Poock, G. K. Effect of Operator Mental Loading on Voice Recognition System Performance. Monterey, CA: Naval Postgraduate School Report NPS55-81-016, 1981.

Armstrong, J. W. and Poock, G. K. Effect of Task Duration on Voice Recognition System Performance. Monterey, CA: Naval Postgraduate School Report NPS55-81-017, 1981.

Baker, J. M. Brief Status Summary for Automatic Speech Recognition at the Start of the 80's. Warrendale, PA: Society of Automotive Engineers Technical Paper 800195, 1980.

Batchellor, M. P. Investigation of Perameters Affecting Voice Recognition Systems in C3 Systems. Monterey, CA: Naval Postgraduate School Thesis, 1981.

Belle, R. T. Bridging the Man-machine Gap. Proceedings of the Human Factors Society--22nd Annual Meeting, 1978.

Booth, A. W. and Barnden, M. S. Voice Input to English Text Output. International Journal Man-Machine Studies, 11, 1979.

Chatfield, D. C.; Marshall, P. H.; and Gidcumb, C. F. Instructor Model Characteristics for Automated Speech Technology (IMCAST). Orlando, FL: Naval Training Equipment Center Technical Report NAVTRAEQUIPCEN 79-C-0085-1, 1979.

Cochran, D. J.; Riley, M.W.; Stewart, L. A. An Evaluation of the Strengths, Weaknesses, and Uses of Voice Input Devices. Proceedings of the Human Factors Society--24th Annual Meeting, 1980.

Connolly, D. W. Voice Data Entry in Air Traffic Control. Federal Aviation Administration Report FAA-NA-79-20, 1979.

Dixon, N. R. and Martin, T. B. (eds). Automatic Speech and Speaker Recognition. New York: IEEE Press and John Wiley and Sons, 1979.

Doddington, G. R. and Schalk, T. B. Speech Recognition: Turning Theory to Practice. IEEE Spectrum, 18, September, 1981.

Gannon, R. Success in the Quest for Machines that Talk. . .and Listen. Popular Science, August, 1980.

Gregory, P. W. and Reaves, J. H. Multi-station Voice Data Entry Configuration Study. Griffiss Air Force Base, NY: Rome Air Development Center Final Technical Report RADC-TR-81-50, 1981.

Hamilton, D. "Then I Said to my Computer. . ." ICP Interface Manufacturing and Engineering, Winter, 1977.

Harris, S. Voice-Interactive Systems: Applications and Payoffs (Proceedings of a Symposium). Warminster, PA: Naval Air Development Center, 1980.

Micklin, M.; Barber, G.; Bollenbacher, J.; Grady, J.; Harry, D.; Meyn, C.; Slemon, G. Ground Controlled Approach Controller Training System. Naval Training Equipment Center Technical Report NAVTRAEQUIPCEN 77-C-0162-6, 1980.

Jay, G. T. An Experiment in Voice Data Entry for Imagery Interpretation Reporting. Monterey, CA: Naval Postgraduate School Thesis, 1981.

Jelinek, F. Self-Organized Continuous Speech Recognition. Warrendale, PA: Society of Automotive Engineers Technical Paper 800198, 1980.

Joost, M. G. and Petry, F. E. Design Factors in the Use of Isolated Word Recognition for Speech Therapy. Proceedings of the Human Factor Society--23rd Annual Meeting, 1979.

Kaplan, G. Words Into Action: I. IEEE Spectrum, 17, June, 1980.

Kato, Y. Words Into Action III: A Commercial System. IEEE Spectrum, 17, June, 1980.

Kneer, C. H. and Popelka, B. A. Automated Speech Processing in Military Team Training. Proceedings of the Human Factors Society--24th Annual Meeting, 1980.

Lea, W. A. Critical Issues in Airborne Applications of Speech Recognition. Warminster, PA: Naval Air Development Center (Code 6041) Final Task Report for Contract No. N62269-78-M-3770, 1979.

Lea, W. A. Trends in Speech Recognition. Englewood Cliffs, NJ: Prentice-Hall, 1980.

Lea, W. A. and Shoup, J. E. Review of the ARPA SUR Project and Survey

of Current Technology in Speech Understanding. Arlington, VA: Office of Naval Research Report for Contract No. N0014-77-C-0570, 1979.

Lerman, L. Voice Data Entry Systems Applications: Proceedings of the Voice Data Entry Systems Applications Conference, 1981. Sunnyvale, CA: Lockheed Missiles and Space Company, 1981.

Levinson, S. E. and Liberman, M. Y. Speech Recognition by Computer. Scientific American, 244, April, 1981.

McCauley, M. E. and Semple, C. A. Precision Approach Radar Training System (PARTS) Training Effectiveness Evaluation. Orlando, FL: Naval Training Equipment Center Report NAVTRAEQUIPCEN 79-C-0042-1.

McSorley, W. J. Using Voice Recognition Equipment to Run the Warfare Environmental Simulator (WES). Monterey, CA: Naval Postgraduate School Thesis, 1981.

Meisel, W. S. Voice-Aided Training. Paper Presented at the Third Interservice/Industry Training Equipment Conference, 1981. Encino, CA: Speech Systems Incorporated, 1981.

Mountford, S. J. and North, R. A. Voice Entry for Reducing Pilot Workload. Proceedings of the Human Factors Society--24th Annual Meeting, 1980.

Neil, D. E. and Andreason, T. Examination of Voice Recognition System to Function in a Bilingual Mode. Monterey, CA: Naval Postgraduate School Report NPS55-81-004, 1981.

Oxenberg, S. C. Segmented Speech--A New Concept in ASR. Delran, NJ: Threshold Technology, Incorporated, 1981.

Poock, G. K. A Longitudinal Study of Computer Voice Recognition Performance and Vocabulary Size. Monterey, CA: Naval Postgraduate School Report NPS55-81-013, 1981.

Poock, G. K. Experiements with Voice Input for Command and Control: Using Voice Input to Operate a Distributed Computer Network. Monterey, CA: Naval Postgraduate School Report NPS55-80-016, 1980.

Reddy, R. Words Into Action II: A Task-Oriented System. IEEE Spectrum, 17, June, 1980.

Rosenberg, A. E.; Flanagan, J. L.; Levinson, S. E.; and Rabiner, L. R. Task Oriented Approaches to Automatic Speech Recognition. Warrendale, PA: Society of Automotive Engineers Technical Report 800196, 1980.

Pothberg, H. Applying Automatic Speech Recognition to Data Entry. Mini-Micro Systems, November, 1980.

Sampei, T.; Asada, A.; and Nakata, K. High Quality PARCOR Speech Synthesizer. IEEE Transactions on Consumer Electronics, CE-26, August, 1980.

Snigier, P. Unlimited Speech Recognition: A Pipe Dream? Digital Design, August, 1980.

Taggart, J. L. and Wolfe, C. D. Voice Recognition as an Input Modality for the TACCO Pre-flight Data Insertion Task in the P-3C Aircraft. Monterey, CA: Naval Postgraduate School Thesis, 1981.

Van Hemel, P. E.; Van Hemel, S. B.; King, W. J.; and Breaux, R. Training Implications of Airborne Applications of Automated Speech Recognition Technology. Orlando, FL: Naval Training Equipment Center Technical Report NAVTRAEQUIPCEN 80-D-0009-0155-1, 1980.

Vidulich, M. and Wickens, C. D. Time-sharing Manual Control and Memory Search: The Joint Effects of Input and Output Modality Competition, Priorities, and Control Order. Arlington, VA: Office of Naval Research, Engineering Psychology Program Technical Report EPL-81-4/ONR-81-4, 1981.

Welch, J. R. and Oxenberg, S. C. Reduction of Minimum Word-Boundary Gap Links in Isolated Word Recognition. Paper Presented at International Conference on Acoustics, Speech, and Signal Processing, ICASSP80, 1980.

--. F-16 To Fly With AFTI/Voice-Operated Cockpit. Flight International, December, 1981.

APPENDIX D

Production Checklists

by
Gordon Ridd, WICAT Systems

Checklist for Video Location Production

Project Title_____ No._____

NO VIDEO WILL BE SHOT UNTIL THE FOLLOWING ARE COMPLETED:

☐ Production Sheets complete and signed-off

☐ Shot Sheets complete

☐ Shot Sheets signed-off

☐ Shot Sheets organized for efficient shooting order

☐ Shot Sheets accompanied by appropriate Production Sheets

☐ Production equipment in working order

- camera
- batteries charged (date_____)
- pan head
- lights and extra lamps (according to checkout)
- scrims and accessories (according to checkout)
- AC cables (according to checkout)
- video cables (according to checkout)
- tape
  - video
  - audio
  - gaffers
- registration charts
- tripod

scene board

☐ Rental equipment scheduled Pickup date_____time_____
Place_____ Return date_____ time_____

- video tape recorder
  - AC power pack
  - batteries charged (date_____)
- monitor
  - batteries charged (date_____)
- waveform monitor
  - batteries charged (date_____)
- microphones
  - batteries
- mixer, preamp, amp
- earphones, speakers
- audio cable (according to checkout)
- AC cable (according to checkout)
- tripod
- pan head
- intercom system
- camera
- lights and extra lamps (according to checkout)
- scrims and accessories (according to checkout)
- video cables (according to checkout)
- registration charts
- scene board
- other_____

☐ Personnel scheduled
Date_____ Time_____ Location_____

- Director
- Cameramen
- VTR operator
- Lighting Director
- Audio Operator
- Project Director
- SME
- location personnel
- Gaffer
- Talent: releases/approvals
- other

☐ Facilities scheduled

- Clearances/approvals
- as per "Location Checkout" list
- coordination with police, fire, other authorities

☐ Travel Arranged

- flights
- motels
- vehicles
- extra equipment freight arranged
- other

Check List for Slide/Photo Location Production

Project Title_____ No._____

NO FILM WILL BE SHOT UNTIL THE FOLLOWING ARE COMPLETED:

☐ Production Sheets complete and signed-off

☐ Shot Sheets complete

☐ Shot sheets signed-off

☐ Shot Sheets organized for efficient shooting order

☐ Shot Sheets accompanied by appropriate Production Sheets

☐ Film purchased
- Type_____ Quantity_____

☐ Equipment
- cameras
- lenses
- filters
- tripods
- magazines
- motor
- batteries
- slave units
- lights and extra lamps (according to checkout)
- scrims and accessories (according to checkout)
- AC cables (according to checkout)
- gaffers tape
- accessory stands (according to checkout)

☐ Travel arranged
- flights
- motels
- vehicles

☐ Facilities arranged and scheduled
- as per "Location Checkout" list

☐ Personnel scheduled
- SME
- Project Director
- Director
- Photographer
- Grip
- Talent: release/approvals
- other

☐ Film processor advised

Checklist for 16mm Film Location Production

Project Title_____ No._____

NO FILM WILL BE SHOT UNTIL THE FOLLOWING ARE COMPLETED:

☐ Production Sheets complete and signed-off

☐ Shot Sheets complete

☐ Shot Sheets signed-off

☐ Shot Sheets organized for efficient shooting order

☐ Shot Sheets accompanied by appropriate Production Sheets

☐ Personnel scheduled
- SME
- Project Director
- Director
- Audio Operator
- Lighting Director
- Cinematographer
- Talent: releases/approvals
- Location personnel

☐ Equipment scheduled
- camera: lenses, motors, magazines
- pan head
- lights and extra lamps (according to checkout)
- screens and accessories (according to checkout)
- filters, matte box
- gaffers tape (according to checkout)
- AC cables (according to checkout)
- batteries (according to checkout)
- tripod (according to checkout)
- booms, cranes, etc.
- microphones
  - batteries
- mixer
- recorder: sync/wild
- headphones
- audio cable (according to checkout)

☐ Facilities scheduled
- clearances/approvals
- as per "Location Checkout" list

☐ Travel arranged
- flight
- motels
- vehicles
- extra equipment freight arranged

Video or Film: Shooting on Location for Stills

Each production needs to be considered for its own needs. Some of the reasons listed below can be considered rather picayune, but are worth considering in some applications.

Art, photos, slides or video intended to be used with compositor need to be considered carefully to be certain they work together.

Things to consider are:

A. Flexibility and cost savings of shooting on location.

B. Flexibility and cost savings of editing materials shot on location.

1. What are you shooting?

a. If shooting gauges or dials and you need each position of the indicator as it passes through all the readings in continuous motion, video can record all the readings in one move and single frames at each reading can be edited from it. Obviously motion of the needle is also available for editing. Fast needle movement will cause blurred stills.
(1) If only a few of these are needed, then slides are cheaper; simulated motion can be created if necessary in editing.

b. When shooting button panels, a group of buttons on a 35mm slide - if not too spread out - can provide up to 6 buttons with one shot. Video can then isolate the buttons in editing.

c. When shooting panels of lights which turn on/off in a particular sequence, video can record them in real time and then by using still frames, each sequence can be taken off the tape during editing.

The same thing can be done by shooting each condition of the lights on a 35mm slide; however, timing would be critical or the presentation of lights would have to be jury-rigged to obtain desired results--either way would require more time. Real time sequencing could also be simulated with the use of slides if necessary.

2. Are you shooting video for motion along with slides? How will the differences in the two media be affected in the continuity of the final product - alternating or in large sequences not to be seen adjacently? There must be compatability of quality and information in the sequences.

a. If you are shooting video for motion and need not shoot many shots for stills, video can do all that slides can except: (1) a little more time will be required to set up and shoot each frame, and (2) you will have to shoot each shot as you want it to appear on the screen (considering whole screen composition). You may have to plan on repositioning the video at an editing facility using digital video effects which may change the appearance of the product for those frames because you have black or a color around the video. This could present a problem.

b. If shooting only for still frames with no motion sequences, slides will be less expensive. If some motion is needed by panning on a slide, it can be done with a video camera. It is not the same effect as video motion on location, however.

3. How many individual shots do you have to shoot?

a. If the number is voluminous (in the hundreds), slides shoot faster. Setting up and getting the shot is much faster, less equipment involved and less alignment time. Slides can be sorted into editing order eliminating search time in editing. Each slide will require some time for adjustment with the video camera in editing. Video, because of facilitating shooting efficiency, may require searching to opposite ends of the tape for up to 3 minutes each. Shooting video for single frames only on location is not practical - each shot would take 1 to 5 seconds on tape requiring multiple reels of tape increasing possible delays in editing to change tapes and/or more cost with more machines.

b. If numbers are few and you have to shoot motion as well, then stills could be done with video to maintain color consistency with no need to train another person on the style to be used, etc.

4. How will they be used on the disc?

a. If each of the pictures stands alone with nothing else on the screen, there is a method for transferring large volumes of slides to video at a much faster rate than normal video editing. This alone makes slides worthwhile for such situations.

b. If the picture is to be mixed with text or another source:

(1) Just a backdrop for text - composition and detail are not so critical, therefore the disadvantages of slides are less significant and a fixed video tape picture will not have to be adjusted.

(2) Text and/or graphics have to be arranged to accommodate portions of the picture - properly shot slides offer more flexibility to fit the adjustments necessary. However, video can be used.

Summary

Disadvantages of slides when edited using a film chain:

1. The way they are shot and mounted is the way they appear on the video signal, therefore creating the same problems described in 2.a.(2) above.

2. The approximate capacity of a film chain is 32 slides. Reloading would be inconvenient and time consuming.

Advantages of slides using a film chain:

1. Resolution is a little better than projecting them on a screen for shooting with a video camera.

Disadvantages of using slides or photos when slides would be projected on a screen and shot with video camera in editing:

1. Framing and composition are a question until you develop the film.

   (a) each slide will require some repositioning by the video camera in editing.

2. The composition of the slide can be a problem:

   (a) If it's too wide, the picture could be too grainy when you get it framed tight enough.

   (b) If too tight, you would have to shoot off the picture or frame it with a switcher pattern which may be inconsistent with content.

3. Color between film and video will be different and may be noticeable especially when shooting the same items.

4. Photos can be sharp if not blown up too far, but they are less flexible than slides because the video camera cannot get as tight on small photos as on slides and mounting them can be cumbersome in editing. *See note.

Advantages of shooting slides or photos to be edited using a video camera:

1. Faster to set up and shoot, therefore, cheaper for quantities.

2. More flexible for stills if shot well.

Disadvantages of video for shooting stills:

1. Requires more time to set up and shoot, therefore, more expensive for quantities.

2. Less flexible in editing if repositioning is required.

Advantages of video for shooting stills:

1. You see what you have at the time you shoot.

   (a) repositioning may not be necessary in editing.

2. You can shoot meters or gauges, etc., in all their settings for single frame or motion.

Checklist for Video Director

(To do or see they are done.)

Project Title_____ No._____

Dates Accomplished

Planning:

1. Attend all planning meetings pertinent to video
2. Screen available video materials with SME and author, determining usable goods
   a. prepare source list
3. Obtain signatures on estimates of types and quantities of production work to be done.
   a. alert those attending that increases in these amounts may cause delays in production deadlines

Authoring:

1. Attend meetings dealing with design of course maps
2. Attend meetings to design disc geography - consult with author and project director
3. Attend meetings dealing with design of video and audio presentation
4. Review storyboard drafts and revisions - all levels
5. Obtain sign-offs of final draft by project director, author, SME

Pre-Production:

1. Obtain needed and available resource materials including originals of existing materials
   a. make necessary dubs/copies/transfers
2. Prepare media production lists:
   a. video shoot
      (1) one sheet or group of sheets per set up
   b. art
      (1) organize into types if done by different artists
   c. photo
      (1) one sheet or group of sheets per set up
   d. existing tape
   e. special effects
      (1) consult with contract editor on requirements and method of doing them
      (2) list in order of editing
   f. props

Dates Accomplished

3. Obtain sign-offs on media production lists
4. Select talent and music - obtain music releases if necessary
5. Schedule needed facilities (and alternates) and personnel
   a. video studio
   b. remote
   c. audio studio
   d. post-production
      (1) In house
      (2) Contracted
   e. mastering - send appropriate forms and purchase order
6. Preview meeting with all possible, pertinent people to present the big picture (artist, photographer, CG operator, editor, prod. assistants, project director, author, SME, etc.)

Production:

1. Confirm that facilities and people are scheduled
2. Oversee phases of production in process See individual production lists for details
   a. video shoots
   b. film
   c. art
   d. props
   e. compositor
   f. audio

   "a" through "e" can be produced simultaneously; however, any Compositor work required to be aligned to work in "a" through "d" will not be done until they are complete
3. Obtain sign-offs on media production lists for work done
4. Collect <u>all</u> production materials, label, and organize them for post-production

In House Post-production:

1. Confirm that facilities and people are scheduled
   a. in house
   b. contracted facilities
2. Off-line editing
   a. select SMPTE's from location tapes
   b. do off-line edit tape if needed
3. Build work tapes
4. Complete Edit Decision List
5. Remind contract editor of special effects requirements
6. Alert contract post-production personnel of the following requirements:

	Dates Accomplished		
Instructions for post-production personnel and equipment:			
1. Compositor in spec.			
2. Machines set up completely, daily			
3. RF levels need to be watched			
4. Periodically check edits for correct field			
5. Watch for color framing where appropriate			
6. Be alert for proper video levels			
7. Don't park the tape down stream after the edit			
Contracted Post-Production			
1. Edit master tape			
a. do appropriate dubs			
2. Screen dub of master tape for correctness			
3. Obtain sign-off of completed master tape			
Disc Mastering:			
1. Send master tape to disc mastering with appropriate forms			
2. Screen "check cassette" and/or "check disc" for quality and completeness			
3. Obtain sign-off on "check cassette" and/or "check disc"			
4. Give screening results to disc manufacturing promptly			

Checklist for Project Directors and Authors

Relative to Videodisc Production

Project Title_____ No._____

	Dates Accomplished		
Planning:			
1. Include video director in planning sessions			
2. Author, SME and Video Director screen existing materials			
3. Sign off estimates of types and quantities of production work to be done			
Authoring:			
1. Include video director in the following:			
a. Designing course map			
b. Designing disc geography			
c. Designing of video presentations - general and specific			
d. Storyboard reviews - all drafts			
2. Include graphics designer in the following:			
a. Design of video presentations - general and specific			
3. Check in with director and graphics designer for feasibility of presentation as authoring progresses			
4. Production sheets			
a. Complete all appropriate information on every sheet			
b. Text for audio and Compositor are proofed			
c. Sign-off of the final draft by the project director, author, SME and director			
Pre-Production:			
1. Consult with director as appropriate			
2. Assist in preparation of media production lists			
3. Sign-off on media production sheets			
4. Consult in selection of talent and music			
5. Attend preview meeting for production			
Production:			
1. Participate in production as appropriate			
2. Review and sign-off production as completed			
3. Adhere to established schedules - costs			

	Dates Accomplished		
Post-production:			
1. Participation off-line editing as appropriate			
2. Participate in building work tapes as appropriate			
3. Participate in editing master tape as appropriate			
4. Review and sign-off dub of master			
5. Adhere to established schedules - costs			
Disc Mastering:			
1. Review and sign-off "check cassette" and/or "check disc"			
Additional Information:			
1. Significant changes or additions in the types and quantities of production work estimated in the "Planning" stage will alter the production deadlines also estimated at that time.			
2. Failure to deliver appropriately signed-off final production sheets by a date agreed upon by the production department will automatically postpone subsequent deadlines. New dates will be determined by the production department.			
3. Changes on or additions to materials in the signed-off final production sheets will automatically postpone subsequent deadlines to dates determined by the production department.			
4. Changes on or additions to any materials that are signed-off will automatically postpone subsequent deadlines to dates determined by the production department.			
5. Delays in production caused by anyone other than production department personnel will automatically postpone subsequent deadlines to a date determined by the production department.			
6. The only Compositor work to be done without a sign-off is for layout design or experimenting with special characters during the "Authoring" stage.			

	Dates Accomplished
7. No work will begin on any stage of the production process without a sign-off on the preceding stage from Authoring through Final Post-production. The sign-off is a statement that, that stage is final as it is with no changes or additions to follow.	

Checklist for Post-Production

Project Title_____ No._____

POST-PRODUCTION WILL NOT BEGIN UNTIL THE FOLLOWING APPLICABLE BOXES ARE CHECKED AND THE UNAPPLICABLE ARE CROSSED OUT.

Production Sheets

- ☐final version updated
- ☐organized according to disc geography
- ☐sufficient copies for all concerned
- ☐signed-off

Props

- ☐organized - list on separate sheet when organizing
- ☐signed-off

Existing materials

- ☐films dubbed to tape and off-lined
- ☐tapes dubbed and off-lined with edit decision list
- ☐slides, photos, art, props collected and organized
- ☐signed-off

Location video

- ☐shot
- ☐dubbed
- ☐off-lined with edit decision list
- ☐signed-off

Location slides

- ☐shot
- ☐processed
- ☐necessary dubs processed
- ☐organized (trayed)
- ☐signed-off

Location photos

- ☐shot
- ☐processed
- ☐necessary dubs processed
- ☐correct sizes/cropping made or indicated
- ☐mounted (organized)
- ☐signed-off

Location film

- ☐shot
- ☐processed
- ☐transferred to video tape
- ☐off-lined with edit decision list
- ☐signed-off

Checklist for Post-Production (cont.)

Art work

- ☐completed
- ☐numbered and organized
- ☐reviewed
- ☐signed-off

Special effects list - if applicable

- ☐complete
- ☐signed-off

Compositor only pages

- ☐completed
- ☐reviewed
- ☐signed-off

Compositor and external source pages

- ☐completed - adjusted to video
- ☐reviewed
- ☐signed-off

Audio - music/narration

- ☐master tape recorded on appropriate medium and speed
- ☐signed-off

No contract post-production work will begin until all post-production work is complete.

Checklist for Location Checkout

Project Title_____ No._____

☐ Media:

- ☐ Video
- ☐ Slide
- ☐ Photo
- ☐ 16mm film

☐ Indoors:

- ☐ Type of existing lighting_____
  - ☐ can be used_____
  - ☐ can be covered_____
  - ☐ need correction_____
- ☐ Lighting requirements_____
  - ☐ no. of lights and types_____
  - ☐ scrims_____
  - ☐ bounce boards_____
  - ☐ filters_____
  - ☐ grip stands_____
- ☐ Sufficient space for equipment and personnel to shoot (camera, VPR, lighting and accessories)
- ☐ Sufficient space for mobile shots - adequate surface and equipment
- ☐ Room to secure equipment overnight
- ☐ Platforms or ladder needed and/or are available_____
- ☐ AC power - no./length of cables_____
  no. of circuits_____ ____ amps/circuit_____
- ☐ Video cable - no./length_____
- ☐ Audio cable - no./length_____

☐ Outdoors:

- ☐ Shade_____
- ☐ Open_____
- ☐ Weather conditions possible/probable_____
- ☐ Light source aids_____
- ☐ AC power - no.length of cables_____
  no. of circuits_____ amps/circuit_____
- ☐ Video cable - no./length_____
- ☐ Audio cable - no./length_____
- ☐ Room to secure equipment overnight
- ☐ Platforms or ladders needed and/or are available_____

☐ Other

- ☐ Necessary local personnel available and scheduled - who_____
- ☐ Facilities scheduled - dates_____
  - ☐ location rooms or area_____
  - ☐ equipment, props, special items, etc.
- ☐ Coordination with police, fire, other authorities

Special Comments_____

_____

Checklist for Contracted Post-Production

Project Title_____ No._____

POST-PRODUCTION WILL NOT BEGIN UNTIL THE FOLLOWING APPLICABLE BOXES ARE CHECKED AND THE UNAPPLICABLE ARE CROSSED OUT.

Post-Production

- ☐work tapes complete - as much as can be done in house
- ☐edit decision list complete

Production Sheets

- ☐final version updated
- ☐organized according to disc geography
- ☐sufficient copies for all concerned
- ☐signed-off

Props

- ☐organized - list on separate sheet when organizing
- ☐signed-off

Existing materials

- ☐films dubbed to tape and off-lined
- ☐tapes dubbed and off-lined with edit decision list
- ☐slides, photos, art, props collected and organized

Location video

- ☐shot
- ☐dubbed
- ☐off-lined with edit decision list
- ☐signed-off

Location slides

- ☐shot
- ☐processed
- ☐necessary dubs processed
- ☐organized (trayed)
- ☐signed-off

Location photo

- ☐shot
- ☐processed
- ☐necessary dubs processed
- ☐mounted (organized)
- ☐signed-off

Checklist for Contracted Post-Production (cont.)

Location film

- ☐ shot
- ☐ processed
- ☐ transferred to video tape
- ☐ off-lined with edit decision list
- ☐ signed-off

Art work

- ☐ completed
- ☐ reviewed
- ☐ numbered and organized
- ☐ signed-off

Compositor only pages

- ☐ completed
- ☐ reviewed
- ☐ signed-off

Compositor and external source pages

- ☐ completed - adjusted to video
- ☐ reviewed
- ☐ signed-off

Special Effects Requirements

- ☐ remind editor of special effects
- ☐ confirm that equipment is prepared
- ☐ special effects list complete
- ☐ sufficient copies prepared
- ☐ signed-off

Edit Decision List

- ☐ complete
- ☐ signed-off

Audio Production Checklist

Project Title_____ No._____ Date Accomp.

AUDIO WILL NOT BE RECORDED UNTIL THE FOLLOWING HAVE BEEN COMPLETED.

- ☐ Obtain sign-off on final, proofed production sheets
- ☐ Select talent, sound effects and music
  - ☐ obtain necessary releases for music
- ☐ Schedule talent
- ☐ Schedule audio studio
  - ☐ narration
  - ☐ mix and/or edit
- ☐ Transcribe audio script from the proofed production sheets for narration, music and sound effects.
- ☐ Obtain sign-off on proofed audio script
- ☐ Give script to narrator for advance preparation
  - ☐ have sufficient copies for all involved.
- ☐ Record narration
- ☐ Mix and/or edit narration, music and sound effects on appropriate master audio tape at appropriate speed
- ☐ Obtain sign-off on audio master tape

Sign-offs

Sign-offs should be done on the production sheets and the media production lists directly rather than on the checklists. A date needs to accompany each sign-off.

The sign-off must be done by the person or persons with final authority.

Sign-offs are needed on the media production lists before production work begins to indicate completeness of sheets on work to be done and how it is to be done.

Sign-offs are needed on media production sheets when work is completed to indicate acceptance of the quality and completeness of the work.

PERIODICALS ABOUT VIDEODISCS

NEWS. Nebraska ETV Network, University of Nebraska-Lincoln, Videodisc Design, Production Group, P. O. Box 83111, Lincoln, NE 68501-3111. No Charge.

Optical Memory Newsletter, including Interactive Videodiscs. Edward S. Rothchild, P. O. Box 14817, San Francisco, CA 94114-0817. $295/yr.

Videodisc News. P. O. Box 6302, Arlington, VA 22206. $150/yr. Checks payable to Videodisc Services, Inc.

Videodisc/Videotex. Meckler Publishing, 520 Riverside Avenue, P. O. Box 405, Saugatuck Station, Westport, CT 06880. $52/yr.